

Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.



AGRICULTURAL ECONOMICS RESEARCH

JANUARY 1979 VOL. 31 NO. 1

1
EC 7 Agr
exp. 2

[Handwritten signature]

COMM. 1979

FEB

DEPT. OF AGRIC.
RECEIVED



Does advertising
change demand
for oranges?
p.1

Agricultural Economics Research

A Journal of the U.S. Department of Agriculture • Economics, Statistics, and Cooperatives Service

Editors

Judith Armstrong
Clark Edwards

James R. Cantwell
Charles Caudell

Editorial Board

Graphic Designers

Harris Goldman
James Vechery

Howard Hogg
William Kost
Jitendar Mann

Staff Assistants

Ann Bassett
Dolores C. Burrell

Roberta Van Haeften
Abner W. Womack

• • •

The first step in economic analysis is to decide what problem is being considered and what end result is desired. For example, firm managers may wish to expand sales, area leaders may want economic growth, industry leaders may need commodity price forecasts.

As a second step, before an end result can be achieved, one must ask what factors might affect the result. What effect does advertising have on sales? What are the sources of economic growth? What effects do monopoly and economies of scale have on commodity prices?

The third step, before relationships between causal factors and end results can be ascertained, includes model building, gathering data, computer programming, statistical testing, and other interesting problems.

Two thousand years ago, Epictetus analyzed the process of truth seeking into three parts. My three steps apply his concepts to agricultural economics. Epictetus pointed out that the third part is necessary because of the second, and the second because of the first. While the first is most necessary, he said, and is where we ought to "remain," we do the reverse. He felt we squander our time in the third part to the utter neglect of the first.

Epictetus was right about the emphasis. Economic analysis does not make sense to me unless it seeks solutions to social problems. Even so, sometimes it is not what we are trying to do that counts, but the way we are doing it. The three articles in this issue address quite different problems, but each gives insight into the importance of method and of finding and using new ways of doing things in agricultural economics research.

Ward and Myers are concerned that our econometric models usually assume a fixed structure, such as a fixed demand relation for a farm commodity. Estimates of this structure are assumed to hold not only for the period studied, but into the forecasted future as well.

This assumption clearly is not the best one when studying, say, advertising, which aims to change the structure of the demand relation. The authors explain how to calculate variable parameter estimates and illustrate the utility of doing so when demand is presumed to change in response to advertising. I see no reason why the method would not apply in other situations as well, when the structure changes not through purposive action such as advertising, but through events which can be taken as random.

Kalbacher considers a method which has been used to identify sources of regional growth for more than three decades, and she examines an alternative formulation. The new version has some advantages over the traditional one, but to gain these advantages, the user has to pay a certain opportunity cost. The method, shift-share analysis, is not generally used in analysis of commercial agriculture, but, again, I see no reason why it could not be applied to, for example, production area shifts in cash receipts from farm commodities.

Lamm reviews some studies which examine economies of scale using the translog function and notes some desirable properties of this function. The translog function allows the relative change in total cost, with respect to a change in factor price, to depend on the scale of operation. He compares the results with less complex functional forms which do not allow this relation, and finds that the relation is significant. Acceptance of the relation affects our understanding of monopoly and economies of scale in the cottonseed processing industry. Thoughtless choice of a convenient functional form can bias the results of a study, and the Lamm article is another illustration of how a little more methodological effort can help us to avoid such bias.

CLARK EDWARDS

Contents

-
- | | |
|----|---|
| 1 | Advertising Effectiveness and Coefficient Variation Over Time
<i>Ronald W. Ward and Lester H. Myers</i> |
| 12 | Shift-Share Analysis: A Modified Approach
<i>Judith Z. Kalbacher</i> |
| 26 | Economies of Scale in Cottonseed Processing
<i>R. McFall Lamm, Jr.</i> |
| | Research Review |
| 34 | <i>The Lessons of Wage and Price Controls—The Food Sector</i>
Reviewed by Abner W. Womack |
| 36 | <i>... And the Desert Shall Rejoice: Conflict, Growth and Justice in Arid Environments</i>
<i>Water Production Functions for Irrigated Agriculture</i>
<i>Selected Water Management Issues in Latin American Agriculture</i>
Reviewed by Harry W. Ayer |
| 39 | <i>Induced Innovation: Technology, Institutions, and Development</i>
Reviewed by Ted Thornton and William B. Back |
| 40 | <i>Environmental Improvement Through Economic Incentives</i>
Reviewed by David Wilson |
| 41 | <i>Policy Studies Journal</i> , Volume 6, No. 4, Summer 1978
Reviewed by Preston E. LaFerney |
| 42 | <i>Unskilled Labor for Development—Its Economic Cost</i>
Reviewed by Jeanne M. O'Leary |
| 44 | Rural Employment Data Gaps
Clark Edwards |
-

The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department.

Use of funds for printing this periodical has been approved by the Director,
Office of Management and Budget, through February 28, 1980.

For sale by the Superintendent of Documents, U.S. Government Printing Office,
Washington, D.C. 20402. \$6.50 a year domestic; \$8.25, foreign.

Advertising Effectiveness and Coefficient Variation Over Time

By Ronald W. Ward and Lester H. Myers*

Models used to forecast or explain behavior are normally based on a regression function:

$$\hat{Y}_t = \sum_{j=0}^k \hat{\beta}_j X_{jt}$$

In such regression models, the $\hat{\beta}_j$ represent OLS estimates of structural parameters; OLS estimates of reduced-form coefficients; or reduced-form estimates derived from statistically estimated structural relationships. When the $\hat{\beta}_j$'s coefficients are estimated using time-series data for observation periods 1 through n , a common problem in forecasting develops. For some period, $n+s$, $\hat{Y}_{n+s}$ tends to deviate from the actual or observed value of Y during $n+s$.

Within the regression model, three particularly disturbing problems frequently occur. First, the observed value (Y_{n+s}) often lies outside an acceptable confidence interval for $\hat{Y}_{n+s}$. Second, the magnitude of the

Changes over time in consumer demand, influenced by advertising, may not be accounted for in traditional, fixed parameter explanatory and forecasting models. A distributed lagged advertising model was developed and tested with coefficients that had random and systematic adjustments. A variable coefficient model clearly captured the dynamic effects of advertising on consumer demand.

Keywords:

*Variable coefficients
Advertising
Demand*

absolute deviation between predicted and actual values tends to increase as s increases. Third, these two problems often occur regardless of the degree of fit obtained in the original regression.

These problems may be caused by several factors including model misspecification, errors in the projected values for the independent variables (X_j 's), and parameter change between period n and the forecast period $n+s$. In this article, we focus on the problems by studying the effectiveness of advertising frozen concentrated orange juice (FCOJ) when demand is suspected to have changed over time. Specifically, our objective is to illustrate the usefulness of varying demand parameter procedures.

VARYING PARAMETER REGRESSION MODELS

The sources of parameter variation can be grouped into three broad categories: (a) structural changes in the economic phenomenon being studied; (b) model misspecification; and (c) aggregation. Technological and institutional changes always lead

to structural changes in economic phenomena. Sources of misspecification are varied but include omission of independent variables, wrong functional form, and use of proxy variables. If the more influential independent variables are excluded, the resulting estimates of the coefficients of the variables included will be biased. The extent and the direction of their bias depends on the strength and direction of correlation between the included and excluded variables. If the strength varies over time, the estimated coefficients of the included variables will not be stable over alternative observation periods (19).¹

Aggregation Can Cause Parameters to Vary

In macromodels, aggregation can be a source of parameter variation as the process generating macrovariables cannot be stationary unless the process generating the underlying microvariables is stationary. Over time, the relative importance of microeconomic agents will change, which may not be reflected in aggregation weights. Another common difficulty is that the aggregated (macro) variables are discrete (indexed as discrete time points) whereas the underlying microvariables may be continuous. This situation often causes parameter variation in macromodels. Lastly, structural changes in the economy give rise to discrete shifts in parameters.

*Associate professor and professor in the Food and Resource Economics Department, University of Florida, respectively. The authors are indebted to the U.S. Department of Agriculture for financial support, and particularly to Richard Haidacher, National Economics Analysis Division (NEAD), ESCS, for encouragement in variable coefficients research at a time when the concept was just beginning to be explored theoretically and had not been applied to agricultural problems. The article is based on research conducted under Contract No. 12-17-06-996-X between NEAD, ESCS, USDA and the Food and Resource Economics Department, University of Florida; and it is Florida Agricultural Experiment Station Journal Series # 1460.

¹ Italicized numbers in parentheses refer to items in Literature Cited at the end of this article.

Methods for Handling Parameter Variance

There are two courses of action to handle varying parameters. First, we can eliminate the parameter variation itself by respecifying the model to account for the above three sources of variation explicitly and we can apply existing econometric methods of estimating constant parameters. Second, we can develop new econometric methods to deal with each pattern of parameter variation. Model re-specification may not be possible because the economic data are nonexperimental, and, even if re-specification could be done, data, time, and money may be too limited.

Types of Parameter Variance

Recently, the hypothesis of parameter variation has been accepted as a real-world situation. Attempts to incorporate explicitly this hypothesis into the estimation procedure have resulted in modified econometric methods that have proven useful. Parameter variation can be classified into three broad categories: (a) nonstochastic, caused by structural change in the economic phenomenon being studied; (b) stochastic and stationary; and (c) stochastic but nonstationary.

Nonstochastic parameter variation is divided further into: (1) discrete variation or switching regression and (2) systematic variation. The former permits only a finite (usually small) number of parameter values; the latter, an infinite number. Various approaches have been tried for switching regression under a variety of assumptions. A widely used procedure has been the incorporation of zero-one shifter variables and/or the use of continuous "time" variables.

More recently, stochastic and stationary parameter variation models (random coefficient models) have been used increasingly. Regression parameter vectors are assumed to be random drawings from a common multivariable distribution with mean vector μ and covariance matrix Σ_μ . If only the intercept is assumed to vary, the model reduces to an analysis of covariance with random effects. The random coefficient models have been

analyzed with a single sample of cross-section data or time-series data or with use of panel data collected over time.

For variations wherein only time or household parameter variation is permitted, see (33, 13, 9, 21, 8, 26, 28, 29, 30, 14, 15, 16, 19).

Stochastic and nonstationary parameter variation models are termed sequential (Markovian) models. Extensive research work on sequential parameter variation is embodied in control theory and the applied physical sciences wherein optimal estimation methods usually known as the Weiner-Kalman-Bucy filters are used (17, 18). For variations to suit economic applications, see (22, 23, 31, 7, 2). An adaptive regression model has been developed wherein only the intercept varies sequentially (3, 4, 5). Models have also been developed for situations in which all the coefficients vary (6, 27, 25).

SEQUENTIAL PARAMETER VARIATION MODELS

Since many sources can cause parameter variation, any explanation (hypothesized pattern) of parameter variation must be sufficiently general to incorporate several possibilities. The pattern assumed by Cooley and Prescott (4-6) is sufficiently general to accommodate many realistic situations. Those assumed by Rosenberg and Swamy (22-26, 28-30) emerge as special cases of that assumed by Cooley and Prescott.

The Cooley-Prescott Explanatory Model

The Cooley-Prescott model assumes that the parameters of the model $Y_t = x_t \beta_t$ are adaptive and subjected to both permanent and transitory changes, wherein x_t is a 1 times (K+1) vector. The transitory changes are temporary shocks whose effects do not persist over time. Permanent changes, as they reflect changes in behavioral, technological, and institutional aspects of the economic phenomenon being studied, are more likely to persist

$$R = \begin{bmatrix} x_1' \Sigma_{\mu} x_1 & 0 & 0 & 0 \\ 0 & x_2' \Sigma_{\mu} x_2 & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & x_T' \Sigma_{\mu} x_T \end{bmatrix}$$

over time and be generated in a systematic pattern. An important feature is that the model picks up structural “drifts” as opposed to uniformly constrained shifts.

The parameter vector β_t is assumed subject to:

(a) transitory changes $\beta_t = \beta_t^P + \mu_t$ and

(b) permanent changes $\beta_t^P = \beta_{t-1}^P + v_t$

wherein μ_t and v_t are identically and independently distributed multivariate normal vector variables with zero mean vectors and covariance matrices Σ_{μ} and Σ_v .

A particular covariance structure used by Cooley and Prescott is $\text{Cov}(\mu_t) = (1-\gamma) \sigma^2 \Sigma_{\mu}$ and $\text{Cov}(v_t) = \gamma \sigma^2 \Sigma_v$, wherein Σ_{μ} and Σ_v are assumed known up to scale factors. Let first elements be one ($\sigma_{11\mu} = \sigma_{11v} = 1$) when the intercept is subjected to the above pattern of variation. Again, Cooley and Prescott’s pattern is sufficiently general to accommodate a wide variety of causes. The proportions γ and $(1-\gamma)$ of the total parameter variation can be attributed to permanent and transitory changes, respectively. The parameter γ represents the speed of parameter adaptation to structural changes in the phenomenon being studied. The larger (smaller) value of γ implies that the sources of parameter variation are more (less) of a permanent nature. Changing elements of Σ_{μ} and Σ_v imply varying rates of changes for the parameters and different degrees of permanency of changes. Parameters are estimated using maximum likelihood procedures. For properties of the estimators, see (4, 5, 6, 3).

The Variable Coefficient Models

Given the sample of T values over time, the variable coefficient (VC) model is written as:

$$y = x\beta + w \quad (1)$$

wherein y is a T times 1 vector, x is a T times (K+1) matrix of explanatory variables, and β is a (K+1) times

1 vector of permanent components for the parameters estimated for the base period T+1. Define

$$\beta_{T+1}^P = \beta_T^P + v_{T+1},$$

then from (a) and (b) earlier on this page, it follows that

$$\beta_{T+1}^P = \beta_t^P + \sum_{s=t+1}^{T+1} v_s \text{ and } \beta_t = \beta_{T+1}^P + \mu_t - \sum_{s=t+1}^{T+1} v_s.$$

The vector of disturbances (w) is defined with the t^{th} element being

$$w_t = x_t \mu_t - x_t \sum_{s=t+1}^{T+1} v_s$$

with the variance-covariance matrix.

$$\text{Cov}(w) = \sigma^2 [(1-\gamma) R + \gamma C] = \sigma^2 \Omega(\gamma) \quad (2)$$

wherein:

$$R = \begin{bmatrix} x_1' \Sigma_{\mu} x_1 & 0 & 0 & 0 \\ 0 & x_2' \Sigma_{\mu} x_2 & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & x_T' \Sigma_{\mu} x_T \end{bmatrix}$$

and $C = (c_{ij})$ and $c_{ij} = \min(T-i+1, T-j+1) x_i' \Sigma_v x_j$. Conditional maximum likelihood estimators of β and σ^2 for a given γ , respectively, are:

$$\hat{\beta}(\gamma) = [x' \Omega(\gamma)^{-1} x]^{-1} x' \Omega(\gamma)^{-1} y \quad (3)$$

and

$$s^2(\gamma) = \frac{1}{T} [(y - x\hat{\beta}(\gamma))' \Omega(\gamma)^{-1} (y - x\hat{\beta}(\gamma))]. \quad (4)$$

The concentrated likelihood function, obtained by substituting $\hat{\beta}(\gamma)$ and $s^2(\gamma)$ for β and σ^2 , respectively, will be a function of $0 \leq \gamma \leq 1$. The optimum value, $\hat{\gamma}$, of γ is the one which maximizes the likelihood function. The ML estimators of β and σ^2 are $\hat{\beta}(\hat{\gamma})$ and $s^2(\hat{\gamma})$.

The procedures assume Σ_μ and Σ_v to be known. Since the relative importance of permanent and transitory changes is determined empirically by $\hat{\gamma}$ and no *a priori* basis exists to assume otherwise, we assume $\Sigma_\mu = \Sigma_v$. Similarly, with no *a priori* basis to believe that random changes in parameters are correlated, we can assume both Σ_μ and Σ_v are diagonal:

$$\Sigma_\mu = \Sigma_v = \begin{bmatrix} 1 & 0 & 0 & . & . & . & 0 \\ 0 & \sigma_{22} & 0 & & & & . \\ 0 & 0 & \sigma_{33} & & & & . \\ . & & & . & & & . \\ . & & & & . & & . \\ . & & & & & . & . \\ 0 & . & . & . & . & . & \sigma_{KK} \end{bmatrix} \quad (5)$$

after normalizing on σ_{11} . To assign numerical values to the σ_{jj} , one alternative frequently used is to calculate the ordinary least squares estimates of the VC model, substitute the covariance matrix of estimates in the matrices Σ_μ and Σ_v , and normalize on $\hat{\sigma}_{11}$. The resulting matrix is $\hat{\Sigma}_\mu$ or $\hat{\Sigma}_v$.

Various assumptions can be evaluated by incorporating different structures for Σ_μ and Σ_v . For example, if one believes that only the constant term is subject to permanent and transitory variation, the proper model would be:

$$\Sigma_\mu = \Sigma_v = \begin{bmatrix} 1 & 0 & . & . & . & 0 \\ 0 & 0 & & & & 0 \\ . & . & . & & & . \\ . & . & . & & & . \\ . & . & . & . & & . \\ 0 & 0 & . & . & . & 0 \end{bmatrix} \quad (6)$$

If one suspects transitory but not permanent variation:

$$\Sigma_\mu = \begin{bmatrix} 1 & 0 & 0 \\ . & \sigma_{22} & \\ . & . & \\ 0 & & \sigma_{KK} \end{bmatrix}, \quad \Sigma_v = \begin{bmatrix} 0 & . & . & . & . & 0 \\ . & . & . & . & . & . \\ . & . & . & . & . & . \\ 0 & . & . & . & . & 0 \end{bmatrix} \quad (7)$$

If the variation among the parameters is not independent, the off-diagonal terms should not be ignored.

The above model has received much attention for its forecasting merits in that β is not calculated for the entire sample period but instead for period $T+1$, which suggests the most recent parameter values should lead to better forecasts. While forecasting is important, this class of VC models is equally important to modeling in general. Frequently, one may suspect changes in the economic responsiveness to a set of exogenous variables but theory provides little clue. The VC models can be used to identify and trace out structural drifts. Finally, statistical problems such as serial correlation, multicollinearity, and heteroskedasticity can sometimes be remedied with the use of VC models.

Given this introduction, we now present a specific case study that illustrates many of the procedure's merits.

ADVERTISING MODEL

Ward's advertising model showed that current consumption of frozen concentrated orange juice is related to price, seasonality, and a distributed lag specification of advertising effectiveness (34). The final model was specified where the dependent variable is expressed in first differences to compensate for serial correlation problems:

$$\dot{q}_t = \alpha_0 + \alpha_1 \dot{p}_t + \alpha_2 s + \sum_{j=0}^N \lambda_{j+1} \dot{a}_{t-j} + \epsilon_t \quad (8)$$

- q_t = per capita consumption of frozen concentrated orange juice (gallons of single-strength equivalent)
 p_t = average quarterly price of FCOJ (dollars/gallon deflated by the Consumer Price Index: 1967=100)
 a_t = advertising expenditures (million dollars)
 s = quarterly seasonal dummy
 t = a series of consecutive numbers beginning with $t=2$ in 3rd quarter 1967 through $t=35$ in 4th quarter 1975
 $\dot{q}_t = q_t - q_{t-1}$, $\dot{p}_t = p_t - p_{t-1}$, $\dot{a}_t = a_t - a_{t-1}$.

This model obviously allows systematic adjustments in the model, as is evident with α_2 . The lagged effect was estimated using a polynomial approximation of different degrees (34). The empirical results indicated that a first-degree polynomial with up to four lags is an acceptable specification of the model.

Initially, we estimated the model with advertising data up to 1973, and the specification restricted the parameters to remain fixed over the sample period. In contrast, advertising is designed to influence consumers' preferences toward the product advertised. Thus, the model specification may be unduly restrictive; λ_j may change over time as consumers are exposed to advertising for the product. Similar arguments may be made for other variables in the model. An alternative would be to allow the parameters to vary with both the systematic and random components.

While Ward's previous work consistently showed a first-degree polynomial model to be satisfactory, we adopt a slight variation in the polynomial model here. We use the apparent lag structure λ_{j+1} , and specify the lagged structure as:

$$\lambda_{(j+1)t} = \beta_{0t} + \beta_{1t} \sqrt[3]{j}$$

This lag structure has properties of the geometric decay function:

$$\left(\frac{\partial \lambda_{j+1}}{\partial j} < 0 \text{ and } \frac{\partial^2 \lambda_{j+1}}{\partial j^2} > 0 \right)$$

assuming $\beta_{0t} > 0$ and $\beta_{1t} < 0$) but can be estimated using the Almon lag procedures.² Similarly, if both the immediate and decay effects from advertising are changing, they can be estimated easily with this definition of λ_{j+1} . The parameters λ_{j+1} may have systematic and random components. Hence, β_0 and β_1 may change systematically with an added random component. Equation (9) now represents an alternative specification of the original equation (8):

$$q_t = \alpha_{0t} + \alpha_{1t} p_t + \sum_{j=0}^4 \lambda_{(j+1)t} a_{t-j} + \epsilon_t \quad (9)$$

The revised model from (9) now follows, with the variation in the Almon lagged structure:

$$q_t = \alpha_{0t} + \alpha_{1t} p_t + \beta_{0t} Z_{1t} + \beta_{1t} Z_{2t} + \epsilon_t \quad (10)$$

The Z_{it} 's follow from the Almon procedure where:

$$Z_{1t} = a_t + a_{t-1} + a_{t-2} + a_{t-3} + a_{t-4}$$

$$Z_{2t} = a_{t-1} + 1.257 a_{t-2} + 1.437 a_{t-3} + 1.580 a_{t-4}.$$

Applying the random coefficient model to (10) should show any path of parameter adjustments over the time period analyzed. If consumption is changing as well as varying seasonally, this would appear in equation (10) in α_{0t} . Similarly, changes in advertising effectiveness and decay become evident with the time adjustments in β_{0t} and β_{1t} . These parameters are especially important for analyzing advertising policies.

We now analyze assumptions using the Cooley and Prescott's random coefficient model.

² Many alternative lag structures were hypothesized and estimated with the OLS model. The polynomial specification adopted proved consistently to give superior statistical results relative to other polynomial specifications. This specification of λ_j decays in a theoretically plausible way. It can be adapted readily to the VC model as only two parameters (β_0 and β_1) completely determine the lagged structure.

$$\hat{\Sigma}_\mu = \begin{bmatrix} 1.000 & & & \\ -0.6787 & 0.5959 & & \\ -0.0311 & 0.0163 & 0.0044 & \\ 0.0079 & -0.0109 & -0.0031 & 0.0032 \end{bmatrix}$$

APPLYING RANDOM COEFFICIENTS

Equation (10) represents the distributed lag structure wherein the parameters can be estimated without transforming the error terms. This preservation of the error structure is, of course, a major advantage of the Almon lag procedure. The parameters in (10) may also be random, as suggested previously. Results of re-estimating Ward's model and including 12 additional quarters of data suggest that the advertising parameters may have changed. Serious questions emerge as to the extended validity of the initial parameters. Also, the re-estimation with ordinary least squares does not clearly define any structural changes that may have occurred. Thus, it seems appropriate, recognizing that change over time occurs, to use random coefficients, which allow for systematic and nonsystematic change.

OLS Base Model

As indicated by Cooley and Prescott, all or some parameters may be fixed or the intercept only may be random. Also, the empirical values for Σ_μ and Σ_v follow from an OLS estimate of (10). Further, equation (10) is altered slightly by including a time variable to permit the intercept to shift in fixed increments (that is, time is a proxy for income and other shifters not explicitly included in the model). Equation (11) provides the inputs for Σ_μ ; the standard errors are in parentheses.

$$\begin{aligned} \hat{q}_t = & 0.5340 - 0.2346 p_t + 0.0163 Z_{1t} \\ & (0.1083) (0.0836) (0.0072) \\ & - 0.0015 Z_{2t} + 0.0076 t \\ & (0.0061) (0.0009) \end{aligned} \quad (11)$$

$$R^2 = 0.9465$$

$$\text{D.W.} = 1.7023$$

The normalized values for the lower triangle of $\hat{\Sigma}_\mu$ are:

$$\hat{\Sigma}_\mu = \begin{bmatrix} 1.000 & & & \\ -0.6787 & 0.5959 & & \\ -0.0311 & 0.0163 & 0.0044 & \\ 0.0079 & -0.0109 & -0.0031 & 0.0032 \end{bmatrix}$$

Σ_μ from equation (11) has been used in the random model primarily because equation (11) captures at least part of the intercept adjustment known to be necessary from prior research. Further, preliminary estimates of Σ_μ using OLS of equation (10) did not change the VC estimates appreciably. Similarly, the varying coefficient estimates are robust for slight deviations from the OLS estimates of Σ_μ .

The subsequent analyses assume the matrices Σ_μ and Σ_v are diagonal and equal. Relaxing this assumption in several estimates indicated only slight differences in the parameter values across models, again supporting the robustness of the estimates with different configurations of Σ_μ and Σ_v .

Random Models

The variable coefficient (VC) model was estimated with quarterly observations for the 4th quarter of 1968 ($t=7$) through the 4th quarter of 1975 ($t=35$). Data for 1976 and 1977 were omitted and used later for validation. Parameters were allowed to change for each observation period and γ , showing the weighting of permanent and transitory effects, indicated that 98 percent ($\gamma=0.98$) of the parameter change was permanent. The proxy trend variable initially included in the fixed model is now dropped as the permanent and transitory adjustments appear in the changing intercept estimates. Equation (12) represents the parameter estimates for period $t=35$ with the standard error in parentheses. This equation corresponds to β_{t+1} initially shown in equation (1).

$$\hat{q}_t = 0.7162 - 0.4139 p_t + 0.0191 Z_{1t} - 0.0057 Z_{2t} \quad (12)$$

(0.1410) (0.1693) (0.0075) (0.0064)

We now illustrate the differences and dynamics of the VC estimates compared with the fixed OLS estimates.

Intercepts

The pattern of intercept adjustments for the random and fixed models over the estimation period appears in figure 1. Intercept α_{0t} moves up somewhat seasonally in the variable model and intercept $\alpha_0 + \alpha_4 t$ is constrained to increase linearly in the fixed model. A more detailed

much stronger growth patterns than may have actually occurred. Applying the fixed model over extended time periods could continually overforecast consumption trends.

Price Coefficients

The VC model estimated only slight downward adjustments in the price coefficient over the time periods analyzed. Current statistical procedures are limited when one attempts to test the significance of these parameter changes over time (11, p. 54; 10, p. 329). However, a more important result is the difference between the fixed and varying price coefficients. The fixed price coefficient was estimated as -0.2346 while the closest value of the random parameter was -0.4044 (fig. 2).

FIGURE 1
Intercept Parameter (α_{0t}) Adjustment
for Fixed and Variable Models

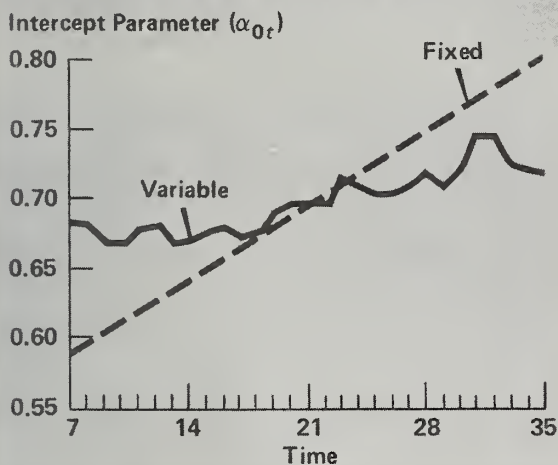
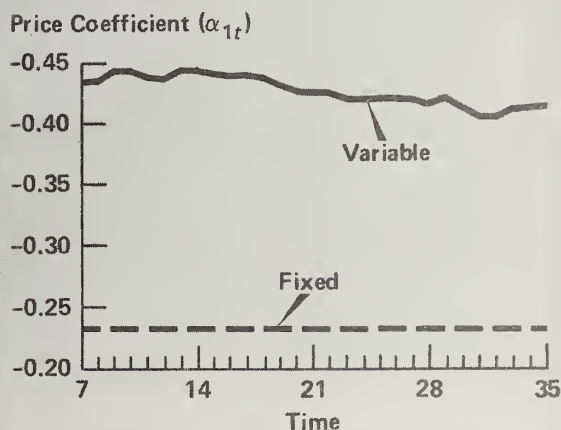


FIGURE 2
Adjustments in Price Coefficient (α_{1t})
in the Variable Model and Comparison
with the Fixed Model



analysis might indicate the type of fixed variables to include to account explicitly for the change. However, a simple time trend adjustment is unduly restrictive. In particular, the fixed model generated lower initial estimated values of the intercept compared with the VC model. For later periods, the fixed model suggested

In all fixed models in which time was used as a proxy for income and growth trends, the price coefficient had small absolute values relative to alternative OLS models which included per capita income instead of time. Prices and time were negatively correlated over the period of the analysis, which may affect estimated coefficient

values directly. Deleting the time variable in the random model reduced the multicollinearity and produced a larger absolute price effect.³

The difference in OLS and VC model estimates can be illustrated further by comparing price elasticity estimates for the end of the sample period used for estimation. With OLS model and price and quantity values for the 4th quarter 1975, the price elasticity is -0.268. With the VC model, it is -0.489.

Although most analyses of VC models emphasize their forecasting merits, the above results suggest that the models are equally useful in identifying specific problems of parameter values throughout the entire sample period. Here, the price parameter is expected to have been underestimated because of multicollinearity. If the trend variable is deleted from the VC model, the systematic adjustment in the intercept reflects the effects initially measured with the time variable in the fixed model and the price coefficient, freed of the multicollinearity problem, can be estimated. Obviously, the usefulness of the VC model is specific to the particular equation.

Random Advertising Effects

Advertising components of the models were calculated wherein β_0 is the immediate effect and β_1 shows the decay. Figures 3 and 4 compare these parameters for the fixed and variable models. The path of adjustment in β_0 clearly shows a positive trend, which indicates that advertising effect has increased during the latter time periods. The systematic adjustments in β_0 suggest some seasonal variation in response to advertising plus the increased advertising effectiveness over time. Also, a comparison of the fixed and variable

³ A similar model to equation (11) was estimated with real per capita shown income rather than time; however, the statistics shown in (11) suggest that its structure is preferable. Price was correlated with both time (t) and income (i) ($\rho(pt) = -0.83$ and $\rho(pi) = +0.80$). The price parameter was estimated to be -0.2346 with the time equation and -0.5305 for the income equation. In contrast, the VC model with the multicollinearity problem removed produced price parameters in the midrange of the fixed models.

FIGURE 3
Adjustments in Advertising Coefficient (β_{0t}) in the Variable Model and Comparison with the Fixed Model

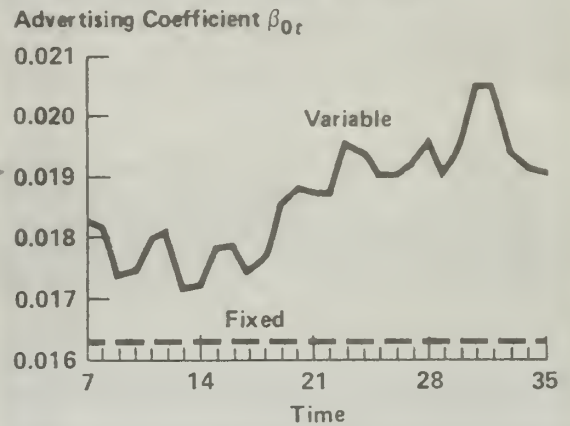
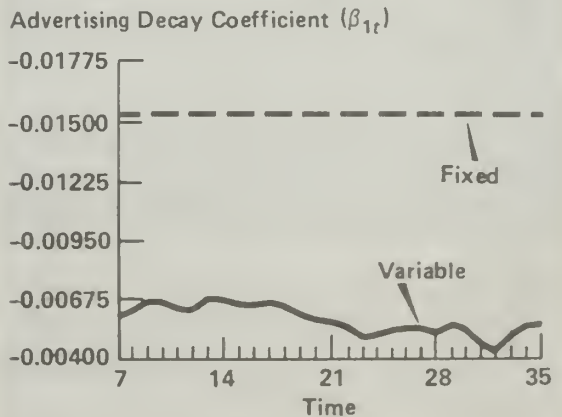


FIGURE 4
Adjustments in Advertising Decay Coefficient (β_{1t}) in the Variable Model and Comparison with the Fixed Model



advertising parameters indicates a substantial numerical difference in the effects of advertising expenditures, one obviously accentuated in the more recent periods.

The decay parameter β_1 also differs considerably from that of the fixed model (fig. 4). This difference is important in that the fixed model suggests a rapid advertising decay while the random model shows that advertising's effect extends over several quarters. In fact, calculating the lagged parameters from

$$\beta_0 + \beta_1 \sqrt[3]{j}$$

shows that the rate of advertising decay has declined over the sample period. That is, not only has advertising become more effective as an immediate demand stimulator but it has also become more effective because its impacts last longer.

The magnitude of impact of an advertising policy is suggested by the estimated effect on orange concentrate sales per capita from a \$1 million advertising expenditure during quarter t over a five-quarter time horizon. The OLS estimates suggest increased per capita FCOJ sales of 0.017 gallons per capita; for the variable coefficient model, 0.065 gallons.⁴ Adjusted for a population of 220 million, the OLS estimates indicated added sales of 3.74 million single-strength gallons versus 14.3 million for the variable coefficient estimates.

While our abilities to test these parameter differences statistically are limited, the numerical values suggest that considerable error can occur when the fixed model is used. The variable coefficient procedure is extremely useful for modeling when structural change is suspected but the systematic component cannot be hypothesized *a priori*.

Model Validation

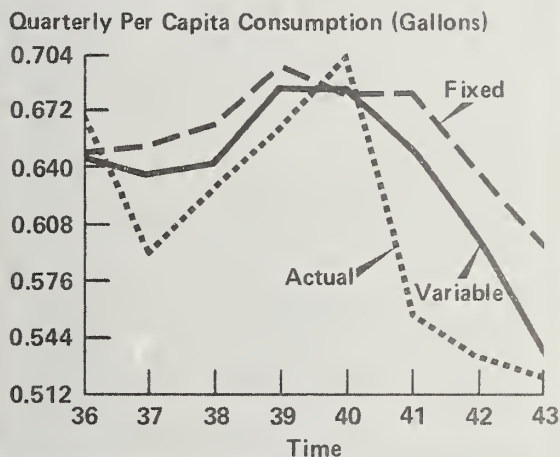
We now briefly compare the accuracy of the two models. As indicated earlier, they were estimated with

⁴ The OLS model actually indicated negative effects after the second quarter. The VC model showed an extended carryover of advertising consistent with the initial first-difference model shown in equation (8). Hence, the comparison above is calculated using two quarters for the OLS model.

data through the fourth quarter of 1975; complete data are available through 1977. We used data from these eight quarters to evaluate the predictive ability of the models.

Generally, the parameter variation model predicted values nearer to actual levels of per capita consumption and it predicted turning points better (that is, the Theil u statistics were $u_{OLS} = 0.197$ and $u_{VC} = 0.132$) (fig. 5). Also, the average absolute error for the OLS model was 54 percent greater than for the VC model (0.0608 versus 0.0395). As the use of the model is extended beyond period 35, the nonstochastic model consistently generated larger errors than did the random model.

FIGURE 5
Forecasting with the Variable and Fixed Models



CONCLUSION

The VC variable model used assumes the parameters estimated for period $T+1$ provide the best equation for forecasting in period $T+k$. This procedure, frequently employed, ignores the systematic parameter patterns that may have occurred over periods 1 to T . Such

patterns can often be captured in re-specified fixed models which in turn would reflect the parameter adjustments in the forecasting periods beyond $T+1$. Thus, we judge the primary usefulness of the VC variable procedures to be for model specification, which, in turn, should lead to improved forecasting. Again, the need for

re-specification depends on the observed parameter patterns. For example, if the parameters tended to plateau after n periods ($1 < n < T+1$), the initial model may not need to be re-specified. In some situations re-specification may recreate the statistical problems initially remedied with the VC model.

LITERATURE CITED

- (1) Belsley, David. "On the Determination of Systematic Parameter Variation in the Linear Regression Model". *Annals Econ. and Social Measurement*. No. 2, Oct. 1973, pp. 495-500.
- (2) Bowman, H. W., and LaPoste, A.M. "Stochastic Optimization in Recursive Equation Systems with Random Parameters". *Annals Econ. and Social Measurement*. No. 1, Jan. 1972, pp. 419-436.
- (3) Cooley, T. F. "Estimation in the Presence of Sequential Parameter Variation". Dept. Econ., Univ. Pa., unpubl. Ph.D. disser., 1971.
- (4) ——— and Prescott, E.C. "Tests of an Adaptive Regression Model". *Rev. Econ. and Statis.* Vol. 55, May 1973, pp. 248-256.
- (5) ———. "The Adaptive Regression Model." *Internat'l. Econ. Rev.* Vol. 14, June 1973.
- (6) ———. "Varying Parameter Regression: A Theory and Some Applications". *Annals Econ. and Social Measurement*. Vol. 2, Oct. 1973.
- (7) Duncan, D. B., and Horn, S. D. "Linear Dynamic Recursive Estimation from the Viewpoint of Regression Analysis". *J. Am. Statis. Assoc.*, Vol. 67, Dec. 1972, pp. 815-821.
- (8) Efron, Bradly, and Morris, C. "Empirical Bayes on Vector Observations: An Extension of Stein's Method". *Biometrika*. Vol. 59, Aug. 1972.
- (9) Fisk, P. R. "Models of the Second Kind in Regression Analysis." *J. Royal Statis. Society Series B*. Vol. 29, 1967, pp. 266-281.
- (10) Froehlich, B. R. "Some Estimators for a Random Coefficient Regression Model". *J. Am. Statis. Assoc.* Vol. 68, No. 342, June 1973.
- (11) Garbade, Kenneth. "Two Methods for Examining the Stability of Regression Coefficients". *J. Am. Statis. Assoc.* Vol. 72, No. 357, Mar. 1977.
- (12) Goldfield, Stephen M., and R. E. Quandt. "The Estimation of Structural Shifts by Switching Regression". *Annals Econ. and Social Measurement*. Vol. 2, Oct. 1973, pp. 475-486.
- (13) Hildreth, C., and Houck, J. P. "Some Estimators for a Linear Model with Random Coefficients." *J. Am. Statis. Assoc.* Vol. 63, 1968, pp. 584-595.
- (14) Hsiao, C. "The Combined Use of Cross-Section and Time-Series Data in Econometric Analysis." Unpubl. Ph. D. disser., Stanford Univ., 1972.
- (15) ———. "Statistical Inference for a Model with Both Random Cross-Sectional and Time Effects." *Internat'l. Econ. Rev.* Vol. 14, No. 1, Feb. 1974.
- (16) ———. "Some Estimation Methods for a Random Coefficient Model." *Econometrica*. Vol. 63, No. 2, Mar. 1975.
- (17) Kalman, R. E. "A New Approach to Linear Filtering and Prediction Problems". *Am. Society Mechan. Engineers, transactions, Series D, Engineering*. Vol. 82, 1960, pp. 35-45.
- (18) ———, and Bucy, R. S. "New Results in Linear Filtering and Prediction Theory." *Am. Society Mechan. Engineers, transactions, Series D, T. Basic Engineering*. Vol. 83, 1961, pp. 95-108.
- (19) Maddala, G. S. *Econometrics*. McGraw-Hill Book Co., New York, 1977, chap. 17.
- (20) Quandt, R. E. "The Estimation of the Parameters of Two Separate Regimes." *J. Am. Statis. Assoc.* Vol. 53, 1958, pp. 873-880.
- (21) Rao, C. R. "The Theory of Least Squares When the Parameters are Stochastic." *Biometrika*. Vol. 52, 1965, pp. 447-458.

-
-
- (22) Rosenberg, Bar. "Regression in the Presence of Stochastically Varying Parameter". Paper, annual meeting, Econ. Society, mimeog., Dec. 1967.
- (23) _____. "Varying Parameter Estimation". Unpubl. Ph.D. disser., Dept. Econ., Harvard Univ., 1968.
- (24) _____. "Linear Regression with Randomly Dispersed Parameters." *Biometrika*. Vol. 60, 1973, pp. 65-72.
- (25) _____. "The Analysis of a Cross-Section of Time Series by Stochastically Convergent Parameter Regression." *Annals Econ. and Social Measurement*. Vol. 2, Oct. 1973, pp. 399-428.
- (26) _____. "A Survey of Stochastic Parameter Regression." *Annals Econ. and Social Measurement*. Vol. 2, Oct. 1973.
- (27) Saris, Alexander. "A Bayes Approach of Estimation of Time Varying Regression Coefficients." *Annals Econ. and Social Measurement*. Vol. 2, Oct. 1973, pp. 501-524.
- (28) Swamy, P. A. V. B. "Efficient Inference in a Random Coefficient Regression Model." *Econometrica*. Vol. 38, 1970, pp. 311-323.
- (29) _____. "Statistical Inference in Random Coefficient Regression Models." Springer-Verlag, Berlin-Heidelberg-New York, 1971.
- (30) _____. "Criteria, Constraints, and Multi-collinearity in Random Coefficient Regression Models." *Annals Econ. and Social Measurement*. Vol. 2, Oct. 1973, pp. 429-450.
- (31) Terasvirta, Timo C. "On Stepwise Regression and Economic Forecasting." *Econ. Studies XXXI*. Finnish Econ. Assoc., Helsinki, 1970.
- (32) Theil, H. *Principles of Econometrics*. John Wiley and Sons, Inc., New York, 1971.
- (33) _____, and Mennes, L. B. "Conception Stochastique de Coefficients Multiplicateurs dans l' Adjustment Lineaire des Series Temporelles." Publications de l'Institut de Statistique de l' Universite de Paris. Vol. 8, 1959, pp. 211-227.
- (34) Ward, R. W. "Measuring Advertising Decay with Polynomial Lags." *J. Advertis. Res.* Vol. 16, No. 4, Aug. 1976, pp. 37-41.

In Earlier Issues

Economists have recognized and accepted the representation of all economic variables of an economy or major segment in terms of a mutually interdependent set defined by a system of simultaneous equations—following the concepts of Walras and Pareto. Most economists and statisticians would be surprised to learn that their procedures in separately fitting individual economic equations to observational data are frequently inconsistent with the postulate of mutual economic interdependence.

Trygve Haavelmo pointed out that the simultaneous character of

a system of economic equations and the mutual and simultaneous determination of a set of interdependent economic variables imposed logical restrictions upon the estimating procedure used to calculate statistical constants for these equations. To Ragnar Frisch is credited the first suggestions leading to development of this new line of analysis.

Review of: *Statistical Inference in Dynamic Economic Models*

Richard O. Been

April 1951, Vol. 3, No. 2, p. 58

Shift-Share Analysis: A Modified Approach

By Judith Z. Kalbacher*

INTRODUCTION

Traditionally, shift-share analysis has been used to describe regional growth or decline of a selected economic variable such as employment or income. The technique was apparently first applied by Daniel Creamer in 1942 (7, pp. 85-104),¹ but it received little attention until Perloff, Dunn, Lampard, and Muth used shift share in a major work in regional analysis (13). Lowell D. Ashby, by introducing the technique to Government research, is credited for recognition and popularity of the method as a tool for regional analysis.²

More recently, as analysts have turned from using descriptive regional statistics to models with predictive capabilities, several have criticized shift share. The pros and cons have been argued elsewhere and will not be presented here (3, pp. 423-425; 5, pp. 1-18; 6, p. 121; 8, pp. 115-120;

This modified version of shift-share analysis presents components of regional economic growth in percentage terms. The version includes a comparative measure of industrial composition not present in traditional shift share. Key components of the modified approach are also shown in graph form to simplify the analysis of regional growth characteristics and the effects of change.

Keywords:

Shift-share analysis
Regional economic growth
Components of regional economic growth
Industry mix
Regional share

10, pp. 577-581). However, in working with shift share, I have found that problems associated with using the technique often stem more from improper interpretation of results than from the methodology itself. When used descriptively to measure economic structure and change in a region against some norm, shift share is both useful and viable.

In this article, I use a different approach to the methodology. Traditionally, results are presented as absolute numbers, which makes direct comparisons between regions and time periods difficult. In this modified approach, results are expressed as percentages to make interregional and intertemporal comparisons easier.³ As another departure, a comparative measure of industrial composition, not present in traditional shift share, is included.

³ L. H. Klaassen and J. H. P. Paelinck also use a relative form of shift-share analysis in (11, pp. 256-261). Other variations of the methodology include: (4, pp. 59-68; 9, pp. 3-8; 12, pp. 283-292; 14, pp. 29-38).

COMPONENTS OF REGIONAL ECONOMIC GROWTH

Both traditional and modified versions of shift-share analysis divide regional economic growth into three components: standard growth, industry mix, and regional share. In the traditional version, an overall growth measure, the standard growth component, represents the norm against which a region's actual growth patterns are evaluated. Standard growth shows what growth would have been if change had occurred at the average rate of expansion in the designated reference economy.⁴ The amount by which actual growth is above or below this norm represents differential regional growth, also termed net relative change.

Net relative change measures the shift of economic activity into or out of a region during a specified period. This shift is traceable either to the region's industrial mix or to the industries' growth performance locally compared with that of their counterparts in the reference economy (regional share).⁵

Because a region rarely produces specific goods and services in the same proportions as the reference economy, the region will experience more or less economic growth

⁴ Frequently, national growth patterns are selected as the standard for comparison. However, other reference economies may be chosen, depending on the user's preference.

⁵ The term locally refers to a characteristic of the particular economy being studied as opposed to the larger reference economy.

*The author is a geographer in the Economic Development Division, ESCS. Special recognition is given to Clark Edwards and Robert Coltrane, who proposed this work on relative shift-share analysis and provided guidance, critical review, and encouragement. Appreciation is extended to Lon C. Cesal for work on various aspects of this article, and to Calvin L. Beale, the author's supervisor, for support and encouragement. Credit is also due to Vera J. Banks and Min-daugas F. Petrusis for their constructive review and to Suprina M. Wilson for her assistance in preparing the article.

¹ Italicized numbers in parentheses refer to items in References at the end of this article.

² Ashby's major contributions using shift share are (1, pp. 13-20; 2,

depending on the industrial specialization. The industry mix component indicates whether local activity is concentrated in sectors which, compared with the reference economy, grew faster or slower. Industry mix enables evaluation of the local economy's industrial composition. Regions with a relatively large positive industry mix component have a preponderance of fast-growth industries. Such regions tend to have a higher propensity for long term growth than do regions with slower growing industries.

Growth attributed to the regional share component is a residual after standard trends and industry mix are allowed for. The regional share shows how the various industrial sectors grow in one region or another because of local economic forces. Growth performance of each industry in each region can be assessed by comparison with those of the reference economy. Here, regions in which industries are expanding more rapidly than their counterparts elsewhere are more likely to attract additional economic activity.

As in traditional shift share, the modified version uses characteristics of a selected economy as a norm for comparisons and accounts for differences between actual and standard growth in terms of industry mix and regional share. The approaches differ in two respects—the modified version is expressed in percentages, and it includes a comparative measure of industrial composition. Although terms common to both versions have similar interpretations, standard growth and industry mix are defined differently. These differences and similarities are further clarified below.

THE METHODOLOGIES⁶

Traditional and this modified version of shift-share analysis may be described algebraically (fig. 1). Both versions require the same data; in this study, employment data for nonmetropolitan counties of nine southern States were used (table 1). These nonmetro

counties serve as the designated reference economy, and nonmetro counties with predominantly black populations (50 percent or more) represent the study area.

Net Relative Change

The first step in applying shift-share analysis to employment change in the predominantly black counties is to determine net relative change—the difference between actual and “standard” growth. In the traditional version, standard growth for each industry of the local region is calculated from aggregate growth in the reference region. In the modified version, specific industry growth rates for the reference region are used instead of the aggregate rate. Each industries' growth is weighted by that industry's importance in the reference region. This weighting introduces industry detail from the reference region into the modified shift share that is not used in the traditional analysis. We thus enhance interpretation of standard growth, but must redefine the industry mix component to incorporate this change.

The following equation expresses net relative change for the *i*th sector of the economy by the traditional version (aggregate growth is the standard):

$$\text{Net Relative Change}_i = r_i R_i - s R_i \quad (1)$$

For the modified version (industry growth is the standard) the equation is:

$$\text{Net Relative Change}_i = r_i \frac{R_i}{R} - s_i \frac{S_i}{S} \quad (2)$$

(For an explanation of individual elements in all equations, see figure 1.)

Agricultural employment data for the black counties during 1970-75 are used to exemplify the characteristics of each approach. In the traditional version, that part of the region's net relative change attributable to agriculture is computed as:⁶

⁶ For all data except when expressed in thousands, multiply numbers by 100 for exact correlation with data in tables.

Figure 1 Traditional and modified shift-share methodologies

Version	Formulation	
	<i>English</i>	
Traditional	Actual growth minus standard growth equals net relative change	industry mix regional share
Modified	Actual growth minus standard growth equals net relative change	industry mix regional share
	<i>Algebraic</i>	
Traditional	$r_i R_i - s R_i = \text{net relative change}$	$(s_i - s) R_i$ $(r_i - s_i) R_i$
Modified	$r_i \frac{R_i}{R} - s_i \frac{S_i}{S} = \text{net relative change}$	$s_i \left(\frac{R_i}{R} - \frac{S_i}{S} \right)$ $(r_i - s_i) \frac{R_i}{R}$

- R_i = base year employment for sector i , in the study region
 R = base year employment for all sectors combined, in the study region
 S_i = base year employment for sector i , in the reference region
 S = base year employment for all sectors combined, in the reference region
 r_i = growth rate during the period for sector i , in the study region
 r = growth rate during the period for all sectors combined, in the study region
 s_i = growth rate during the period for sector i , in the reference region
 s = growth rate during the period for all sectors combined, in the reference region

Table 1—Data for traditional and modified versions of shift-share analysis

Industry	Standard employment ¹			Regional employment ²		
	1970	1975	Growth rate 1970-75	1970	1975	Growth rate 1970-75
	<i>Thous.</i>		<i>Pct.</i>	<i>Thous.</i>		<i>Pct.</i>
Agriculture, forestry, and fisheries	269.3	262.4	-2.56	59.1	56.8	-3.89
Mining	59.3	75.3	26.98	2.9	3.8	31.03
Manufacturing	1,705.6	1,738.5	1.93	105.4	105.5	.09
Contract construction	198.5	233.7	17.73	16.1	19.2	19.25
Transportation, communications, and public utilities	174.5	188.8	8.19	14.9	16.7	12.08
Wholesale and retail trade	683.4	810.4	18.58	62.7	71.9	14.67
Finance, insurance, and real estate	100.9	135.3	34.09	7.7	10.5	36.36
Services	773.5	820.1	6.02	102.8	103.2	.39
Government, including military	911.8	1,061.2	16.39	92.1	107.2	16.40
Total wage and salary employment	4,876.8	5,325.7	9.20	463.7	494.8	6.71

¹ The economy used as a standard of comparison contains nonmetropolitan counties of Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, and Virginia. Also included are Gadsden and Jefferson counties in Florida and Waller county in Texas. ² The regional economy contains a subset of the above counties, specifically counties that in 1970 had a population that was 50 percent or more black.

Source: Unpublished data from the Bureau of Economic Analysis, U.S. Dept. Commerce.

$$\begin{aligned}
 \text{Net Relative Change} &= (-0.0389)(59.1) - (0.0920)(59.1) \\
 &= (-2.3) - (5.4) \\
 &= -7.7 \text{ (thousands)}
 \end{aligned}$$

In the modified version, the computation is:

$$\begin{aligned}
 \text{Net Relative Change} &= (-0.0389) \left(\frac{59.1}{463.7} \right) - (-0.0256) \left(\frac{269.3}{4,876.8} \right) \\
 &= (-0.005) - (-0.0014) \\
 &= -0.0036 \text{ (or, -0.36 percent)}
 \end{aligned}$$

Based on the traditional version, if agricultural employment had changed at the overall rate of expansion in the reference economy (0.0920), it would have increased by 5,400; however, it factually declined by 2,300 in these counties. The net of these two figures (-7,700) measures that part of overall net relative change attributable to the agricultural sector of the economy.

In the modified version, each element of the equation is in relative (percentage) form to facilitate direct comparisons between regions and time periods. Actual growth is a function of the local growth rate and proportion employed in agriculture in the black counties, while standard growth is a function of the standard growth rate and proportion employed in agriculture in the reference counties. Standard growth is measured quite differently in this version. The standard growth rate for agriculture is used rather than for the overall

economy, and agricultural employment data are used for the reference counties, not for the black counties.

For the agricultural sector then, that part of the region's net relative change traceable to agriculture (-0.0036) is computed as the difference between the sector's contribution to the overall regional growth rate (actual growth is -0.0050) and to that of the larger reference economy (standard growth is -0.0014). Values for other sectors of the economy are similarly derived. Net relative change for the total economy of the black counties may be obtained either by applying aggregate data to the equations or by summing individual values for sectors.

Table 2 shows traditionally gained results for all sectors and the aggregate economy—for the black counties; table 3 presents results using the modified version. Based on either method, these counties experienced a net loss of jobs, traceable either to the industry mix or regional share component.

Industry Mix

The industry mix component is a function of industrial sectors in a region and the growth status of each sector in the reference economy. Traditionally, the mix relationship for the i th sector is expressed by:

$$\text{Industry Mix}_i = (s_i - s) R_i \quad (3)$$

This component identifies the fast- and slow-growth sectors in the black counties. Industrial composition in the reference region is not considered. Inclusion of a comparative measure of industrial composition in the modified version strengthens the usefulness of the industry mix measure compared with the traditional version.

In the modified form, the mix relationship for the i th sector is expressed by:

Table 2—Traditional shift-share component values for nonmetropolitan black counties of selected southern States, 1970-75

Industry	Actual growth	Standard growth	Net relative change	Industry mix	Regional share
	<i>Thousands</i>				
Agriculture, forestry, and fisheries	-2.3	5.4	-7.7	6.9	0.8
Mining	.9	.3	.6	.5	1
Manufacturing	.1	9.7	-9.6	7.7	1.9
Contract construction	3.1	1.5	1.6	1.4	2
Transportation, communications, and public utilities	1.8	1.4	.4	.2	6
Wholesale and retail trade	9.2	5.8	3.4	5.9	2.5
Finance, insurance, and real estate	2.8	.7	2.1	1.9	.2
Services	.4	9.4	9.0	3.2	5.8
Government, including military	15.1	8.5	6.6	6.6	.0
Total wage and salary employment	¹ 31.1	¹ 42.7	¹ -11.6	² -1.7	² -9.9

¹ Figure may be obtained by applying aggregate data to the appropriate equation or summing values for individual sectors.

² Figure may only be obtained by summing values for individual sectors.

Note Due to rounding some of the expressed equalities did not exactly balance. In such cases, results were adjusted to compensate for rounding error.

Table 3—Modified shift-share component values for nonmetropolitan black counties of selected southern States, 1970-75

Industry	Actual growth	Standard growth	Net relative change	Industry mix	Regional share
	<i>Percent</i>				
Agriculture, forestry, and fisheries	-0.50	-0.14	-0.36	-0.19	-0.17
Mining	.20	.33	-.13	-.16	.03
Manufacturing	.02	.67	-.65	-.23	-.42
Contract construction	.67	.72	-.05	-.10	.05
Transportation, communications and public utilities	.39	.29	.10	-.03	.13
Wholesale and retail trade	1.98	2.60	-.62	-.09	-.53
Finance, insurance, and real estate	.60	.71	-.11	-.14	.03
Services	.09	.95	-.86	.38	-1.24
Government, including military	3.26	3.07	.19	.19	.0
Total wage and salary employment	¹ 6.71	¹ 9.20	¹ -2.49	² -.37	² -2.12

¹ Figure may be obtained by applying aggregate data to the appropriate equation or summing values for individual sectors.

² Figure may only be obtained by summing values for individual sectors.

Note: Due to rounding some of the expressed equalities did not exactly balance. In such cases, results were adjusted to compensate for rounding error.

$$\text{Industry Mix}_i = s_i \left(\frac{R_i}{R} - \frac{S_i}{S} \right) \quad (4)$$

The difference between employment proportions in each sector explicitly discloses local sectors with greater or less than standard volume of activity. These sectors most influence the study region's growth *vis-a-vis* other regions. The influence will be positive when employment is proportionately more in the region and negative when less, compared with the standard.

The difference between local and standard structures is weighted by the reference region's sector growth. This weight, combined with the difference in proportions, determines the magnitude of the mix value. The sign depends on whether the industry is relatively more or less concentrated in the region and whether reference industry growth was positive or negative, compared with the standard.

While the industry mix component in both shift-share

versions characterizes a given region's industrial composition, the way in which growth attributed to this component is distributed among sectors differs between versions. For the agricultural sector, traditional shift share computes a mix value as follows:

$$\begin{aligned} \text{Industry Mix} &= [(-0.0256) - (0.0920)] 59.1 \\ &= -6.9 \text{ (thousands)} \end{aligned}$$

and the modified version computes the sector's mix value as:

$$\begin{aligned} \text{Industry Mix} &= -0.0256 \left[\frac{(59.1)}{(463.7)} - \frac{(269.3)}{(4,876.8)} \right] \\ &= -0.0019 \text{ (or } -0.19 \text{ percent)} \end{aligned}$$

In the traditional version, which compares a local decline in agricultural employment with rapid general growth in the reference region, agriculture negatively influenced regional growth in employment; a loss of 6,900 jobs occurred. In the modified version, which compares local agriculture with a declining reference agriculture, the industry's mix effect was moderately negative. The black counties were more heavily committed to agriculture than the reference counties. The mix value of -0.0019 equals the amount by which the overall growth rate was lowered. While both versions show negative mix values, basic conceptual differences exist between forms of the mix relationship. Under other conditions of concentration or growth, differences in sign as well as magnitude may be found. Compare the column of mix values in table 2 with its counterpart in table 3.

For both versions, the industry mix value for the total economy is obtained by summing the values of individual sectors—it cannot be computed from aggregate data.

Regional Share

The regional share component relates growth of local sectors to that of their counterparts in the reference economy. The only difference in this component between the two versions is that the traditional uses actual figures whereas the modified uses proportions. Equation 5 defines this component in traditional shift share for the i th sector as:

$$\text{Regional Share}_i = (r_i - s_i) R_i \quad (5)$$

and equation 6 for the modified version as:

$$\text{Regional Share}_i = (r_i - s_i) \frac{R_i}{R} \quad (6)$$

Each sector's growth rate in the local economy is compared with its rate in the reference economy and weighted by the employment ratio. The component's effect is thus stronger for industries with either a large

difference in regional and standard growth rates or a large proportion of regional employment. The effect will be positive when the regional growth rate is more and negative when less than the standard. For traditional shift share, this value for agriculture equals:

$$\begin{aligned} \text{Regional Share} &= [(-0.0389) - (-0.0256)] 59.1 \\ &= -0.8 \text{ (thousands)} \end{aligned}$$

For the modified version:

$$\begin{aligned} \text{Regional Share} &= [(-0.0389) - (-0.0256)] \frac{59.1}{463.7} \\ &= -0.0017 \text{ (or, } -0.17\%) \end{aligned}$$

Both versions indicate that agriculture in the black counties failed to keep pace with the set standard. This poor growth performance means a loss of 8,000 jobs by the traditional approach, and a lowering of the regional growth rate by 0.0017 (0.17 percent) by the modified approach.

To obtain the regional share component for the overall economy, sum values of individual sectors. The overall total reveals whether more of the study area's activity is concentrated in sectors growing faster (positive value) or slower (negative value) than their counterparts, and, combined with the overall mix value, gives net relative change. This behavior also applies at the sector level.

RESULTS

Change in agricultural employment from 1970 to 1975 in nonmetro black counties of nine selected Southern States did not keep pace with standards established in all nonmetro counties of these States. By traditional shift share, the black counties lost 7,700 jobs due to adverse industry mix (-6,900) and regional share (-800) effects. The modified approach, also indicating an outward shift of agricultural employment, measures this loss in terms of the effect on the growth rate rather than

actual jobs. The black counties' overall growth rate was 0.36 percent less because of the concentration and growth in agriculture. This loss traces to adverse effects from industry mix (-0.19 percent) and regional share (-0.17 percent).

As a final technical point, results of the modified approach easily convert to actual employment figures, by multiplying base year total employment in the study region by the appropriate percentage.⁷ For instance, applying the net percentage change effect for agriculture (-0.36) to overall employment (463,700) yields actual jobs lost of 1,700, compared with a loss of 7,700 jobs computed by the traditional method. By the same procedure, employment numbers may be computed for each component at the sector and aggregate levels. At the aggregate level, all employment figures obtained by

converting relative results equal those derived from the traditional analysis, but at the sector level, only those for actual growth and regional share are equivalent. Table 4 presents actual employment figures based on the modified version.

SHIFT SHARE: A GRAPHIC TWIST

Often, shift-share analysis provides too much information for easy interpretation and understanding. Simplification is deemed necessary to clarify how internal and external factors affect a region's characteristics of growth and composition and thereby, its status with respect to other regions.

One approach is to graph industry mix and regional share, so that conditions of growth and composition are associated with quadrant location. This twist not only provides clarity but it also is useful in planning strategies for change.

Table 4—Converted results of the modified shift-share analysis

Industry	Actual growth	Standard growth	Net relative change	Industry mix	Regional share
<i>Thousands</i>					
Agriculture, forestry, and fisheries	-2.3	-0.6	-1.7	-0.9	-0.8
Mining	.9	1.5	-.6	-.7	.1
Manufacturing	.1	3.1	-3.0	-1.1	-1.9
Contract construction	3.1	3.3	-.2	-.4	.2
Transportation, communications, and public utilities	1.8	1.3	.5	-.1	.6
Wholesale and retail trade	9.2	12.1	-2.9	-.4	-2.5
Finance, insurance, and real estate	2.8	3.3	-.5	-.7	.2
Services	.4	4.4	-4.0	1.8	-5.8
Government, including military	15.1	14.2	.9	.9	.0
Total wage and salary employment	¹ 31.1	¹ 42.7	¹ -11.6	² -1.7	² -9.9

¹ Figure may be obtained by applying aggregate data to the appropriate equation or summing values for individual sectors.

² Figure may only be obtained by summing values for individual sectors.

Note: Due to rounding, column sums may not exactly equal independently computed totals. Also, some of the expressed equalities did not exactly balance. In such cases, results were adjusted to compensate for rounding error.

"Both the growth and composition terms in the equation may be positive or negative and they may combine in several ways to affect the overall mix value."

Graphing the Industry Mix Component

Industry mix for the aggregate economy is the sum of industry mix components for each industry calculated by equation (4):

$$IM = \sum_{i=1}^n s_i \left(\frac{R_i}{R} - \frac{S_i}{S} \right) \quad (7)$$

Both the growth and composition terms in the equation may be positive or negative and they may combine in several ways to affect the overall mix value. Figure 2 shows the mix relationship; each quadrant is associated with a unique set of growth and composition characteristics.

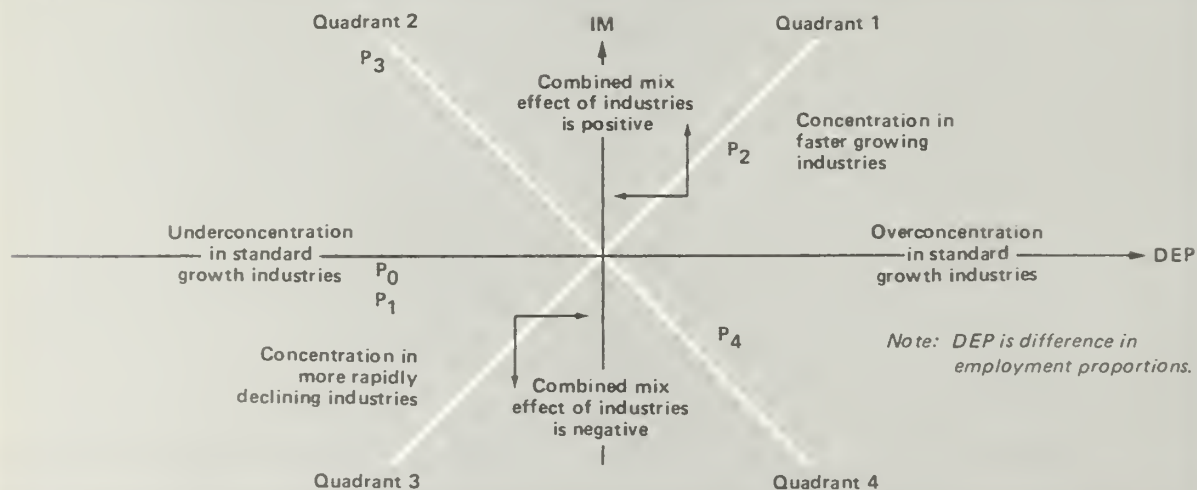
The vertical axis of the figure plots the industry mix value, and the horizontal axis, a variable designated the difference in employment proportions (DEP). This vari-

able indicates the divergence of local and standard industrial structures. At the individual sector level, DEP is simply the difference between the proportion of local and standard employment in a given industry, as expressed by the comparative composition term in the industry mix equation. For example, using the data presented in table 1, the DEP for agriculture is computed as follows:

$$\begin{aligned} DEP &= \left(\frac{59.1}{463.7} \right) - \left(\frac{269.3}{4,876.8} \right) \\ &= .0723 \text{ (7.2 percent)} \end{aligned}$$

As the sum of DEP's for all sectors by definition equals zero, an alternative means of approximating the overall divergence in structures is necessary. Individual DEP's

FIGURE 2
The Industry Mix (IM) Component



can be combined in several ways to obtain an overall measure. Two meaningful ones would be the sum of DEP’s for either growing or declining industries. The DEP’s of growing industries show overconcentration (positive value) or underconcentration (negative value) of local employment in industries growing in the standard economy. The DEP’s of declining industries show overconcentration or underconcentration in declining industries. As to interpretation of results, it makes little difference which measure is selected because one is the negative value of the other. The horizontal dimension is defined by the differences in growing industries.

In addition to the vertical and horizontal axes, 45 degree diagonals mark equal unit changes in the IM value and DEP. These lines divide each quadrant into two sections which differentiate based on industry growth rates. Within quadrants 1 and 2, for example, a location in the upper section identifies a region specializing in industries with higher growth rates than one located in the lower section. Similarly, for quadrants 3 and 4, the sections closer to the vertical axis indicate concentration in industries with lower growth rates than those in the sections closer to the horizontal axis.

A region’s position on the graph depends on the combined mix effect of all its industries. Change in the impacts of any industry places the region in a new location on the graph. In general, change involves vertical and horizontal movement. Movement may originate internally, by changing the local distribution of employment among industries, or externally, by changing either the standard employment distribution or industry growth rates. The direction and extent of movement, of course, depends on the nature of the change.

Consider the employment data for the chosen standard and reference economies. Slightly varying this data results in new graphic position. Table 5 shows values derived from the actual employment data (the DEP is -7.23 percent and the IM is -0.37 percent, represented by P_0 on figure 2). Table 5 also shows values after selected changes were made in the data to exemplify the effect of slightly different growth and composition characteristics.

The first change involved employment in two growing industries. The proportion of local employment in government was raised while that in wholesale and retail trade was lowered. The effect was nominal. Point P_1

falls in quadrant 3 of figure 2 close to P_0 . The IM value is slightly lower because concentration was increased in a growth industry at the expense of a more rapidly expanding industry. The second change involved employment in a declining and a growing industry. The net effect was to raise the IM value. This shift, indicated by P_2 , also changed the DEP from negative to positive.

Changing the standard industry growth rates has an effect similar to that produced by changing the composition term. Changes 3 and 4 illustrating such effects are shown in table 4 and figure 2. The conditions presented under change 3 appear in the second quadrant. Although local employment is underrepresented in growth industries, industry mix is positive due to the influence of a very rapidly expanding industry (in this case, services). Finally, the conditions shown under change 4 appear in the fourth quadrant. Here, local employment is overrepresented in growth industries, but, due to the influence of a rapidly declining industry (agriculture), the IM value is negative.

While it would be somewhat speculative to pinpoint ideal location on the graph, the following conclusions may be justifiably drawn. First, it is desirable for a region to maximize its industry mix value. Second, it is generally better for the region to maximize the IM value while minimizing local divergence from the chosen standard characteristics. These conditions are best met in the upper sections of the first and second quadrants. Overrepresentation in growth industries is preferable, so quadrant 1 is preferable to quadrant 2. The upper portion of quadrant 1 is, therefore, the better location.

Graphing the Regional Share Component

Regional share for the overall economy being studied equals the sum of regional share components for each industry calculated by equation (6):

$$RS = \sum_{i=1}^n (r_i - s_i) \frac{R_i}{R} \quad (8)$$

Again, both the growth and composition terms in the equation may be positive or negative and they may

Table 5—Industry mix (IM) values after selected changes

Element	Actual values of variables	Change 1 ¹	Change 2	Change 3	Change 4
<i>Percent</i>					
Growth rates in reference region:					
Agriculture	-2.56	-2.56	-2.56	-2.56	-102.56
Mining	26.98	26.98	26.98	26.98	26.98
Manufacturing	1.93	1.93	1.93	1.93	-50.00
Construction	17.73	17.73	17.73	17.73	17.73
Transportation, communications, and public utilities	8.19	8.19	8.19	8.19	8.19
Wholesale and retail trade	18.58	18.58	18.58	18.58	18.58
Fire, insurance, and real estate	34.09	34.09	34.09	34.09	34.09
Services	6.02	6.02	6.02	106.02	6.02
Government	16.39	16.39	16.39	16.39	16.39
Difference in employment percentages:					
Agriculture	7.23	7.23	-5.52	7.23	7.23
Mining	-59	-59	-59	-59	-59
Manufacturing	-12.24	-12.24	-12.24	-12.24	-12.24
Construction	-60	-60	-60	-60	-60
Transportation, communications, and public utilities	-37	-37	-37	-37	-37
Wholesale and retail trade	-49	-14.01	-49	-49	-49
Fire, insurance, and real estate	-41	-41	-41	-41	-41
Services	6.31	6.31	6.31	6.31	6.31
Government	1.16	14.68	13.91	1.16	1.16
DEP value	-7.23	-7.23	5.52	-7.23	5.01
IM value	-37	-66	2.05	5.94	1.25

¹ Changed values are underlined.

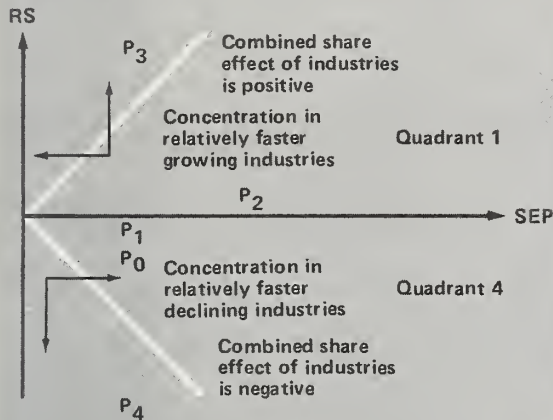
combine in several ways to affect the overall regional share value (figure 3).

The vertical axis plots the regional share value and the horizontal axis, a variable termed the sum of employment proportions (SEP), which measures local efforts to bring jobs into the region. Specifically, SEP is the sum proportion of local employment in industries outpacing the growth of their standard counterparts. Comparing

the two columns of growth rates in table 1, for example, shows five industries grew faster in the group of black counties than in all nonmetro counties of the same States. Since employment levels are somewhat low for these five industries, summing the proportions employed in each yields as overall SEP value of only 0.2883 (28.83 percent). The magnitude of the SEP value indicates the degree of specialization in industries competing

successfully in attracting jobs to the study region. SEP ranges in value from zero to one; accordingly, the horizontal axis of the graph extends only in the positive direction from zero to one.

FIGURE 3
The Regional Share (RS) Component



NOTE: SEP is sum of employment proportions. Because its values are always positive, Quadrants 2 and 3 are not shown.

In the figure, diagonals drawn at 45 degrees to the origin mark equal unit changes in the regional share (RS) value and SEP. These lines divide the two quadrants on the graph into sections based on industry growth rates. Within quadrant 1, a location in the upper section nearer the vertical axis identifies a region in which local industries outpace their standard counterparts more so than in a region located in the section closer to the horizontal axis. Similarly, in quadrant 4, location in the lower section nearer the vertical axis indicates a region in which local industries fall behind their standard counterparts more so than in a region in the section closer to the horizontal axis.

A region's position on the graph depends on the

combined share effect of all its industries. This position shifts in response to change, which may be introduced internally by changing either the local employment distribution or industry growth rates, or externally, by changing the standard industry growth rates. The direction and extent of movement depend upon the nature of the change.

To illustrate the responsiveness of the regional share component to change, selective changes were made in the actual employment data and the regional share was recomputed to reflect new conditions (table 6).

The first change decreased the proportion of employment in services and increased that in agriculture. Because local growth in agriculture fell below its standard counterpart less than occurred in the service industry, the RS value rose. The original characteristics and those after the change are summarized in figure 3 at points P_0 and P_1 , respectively. The second change in the data had a similar effect, but, in this case, the shift of employment also increased SEP, as the shift was into an industry outpacing its standard counterpart. The coordinates marked by P_2 describe the new conditions.

The last two changes in the data were made to show the extent to which a region's competitive position may be influenced, first, by the presence of an exceedingly fast growing industry (change 3) and, second, by a correspondingly slow growing industry (change 4). In change 3, the local growth rate of government was raised so that it greatly exceeded the standard. Change 4 involved lowering the local growth rate of manufacturing so that such growth fell far below the standard for this industry. In accordance with the characteristic conditions summarized in figure 3, the coordinates reflecting these new conditions are located, in order, above the upper diagonal at P_3 and below the lower diagonal at P_4 .

In defining the boundaries of good location on this graph, the following objectives should be considered. The first objective, of course, is to maximize the regional share value and next, to maximize employment in industries growing faster than their standard counterparts. These conditions are best met along the diagonal in quadrant 1 on the graph.

Table 6—Regional share (RS) values after selected changes

Element	Actual values of variables	Change 1 ¹	Change 2	Change 3	Change 4
	<i>Percent</i>				
Difference in growth rates:					
Agriculture	-1.33	-1.33	-1.33	-1.33	-1.33
Mining	4.05	4.05	4.05	4.05	4.05
Manufacturing	-1.84	-1.84	-1.84	-1.84	-200.00
Construction	1.52	1.52	1.52	1.52	1.52
Transportation, communications, and public utilities	3.89	3.89	3.89	3.89	3.89
Wholesale and retail trade	-3.91	-3.91	-3.91	-3.91	-3.91
Finance, insurance, and real estate	2.27	2.27	2.27	2.27	2.27
Services	-5.63	-5.63	-5.63	-5.63	-5.63
Government	.01	.01	.01	<u>200.00</u>	.01
Proportion employed in study regions:					
Agriculture	12.75	<u>34.91</u>	12.75	12.75	12.75
Mining	.63	.63	<u>22.79</u>	.63	.63
Manufacturing	22.73	22.73	<u>22.73</u>	22.73	22.73
Construction	3.47	3.47	3.47	3.47	3.47
Transportation, communications, and public utilities	3.21	3.21	3.21	3.21	3.21
Wholesale and retail trade	13.52	13.52	13.52	13.52	13.52
Finance, insurance, and real estate	1.66	1.66	1.66	1.66	1.66
Services	22.17	.01	.01	22.17	22.17
Government	19.86	<u>19.86</u>	<u>19.86</u>	19.86	19.86
SEP value	28.83	28.83	<u>50.99</u>	28.83	28.83
RS share	-2.12	<u>-1.32</u>	.01	<u>37.60</u>	<u>47.16</u>

¹ Changed values are underlined.

Merits of Graphic Approach

Through this graphic twist to shift-share analysis, analysts can readily examine composition and growth characteristics and the effects of change. The figures clarify how internal and external factors affect a region's growth components and its status with respect to other regions.

Planners will also find the graphic approach especially useful, as it provides a well-structured vehicle for evaluating the impact of change. The approach may also be used simply to summarize a region's characteristics

for various time periods or to compare characteristics of numerous regions simultaneously.

CONCLUSIONS

This modified version of shift-share methodology, although not a predictive model, can be used to compare and appraise past and present economic growth patterns of regions. Regions can be classified objectively over time and their growth patterns can be compared over time and with one another.

REFERENCES

- (1) Ashby, Lowell D. "The Geographical Redistribution of Employment: An Examination of the Elements of Change." *Surv. Current Business*. Vol. 44, 1964.
- (2) _____. *Growth Patterns in Employment by County, 1940-50 and 1950-60*. Off. Business Econ., U.S. Dept. Commerce, Wash., D.C., 1965.
- (3) _____. "The Shift and Share Analysis: A Reply." *So. Econ. J.* Vol. 33, No. 3, 1968.
- (4) Bishop, K. C., and C. E. Simpson. "Components of Industrial Change Analysis: Problems of Alternative Approaches to Industrial Structure." *Regional Studies*. Vol. 6, 1972.
- (5) Brown, H. J. "Shift and Share Projections of Regional Economic Growth: An Empirical Test." *J. Regional Sci.* Vol. 9, 1969.
- (6) _____. "Shift and Share Projections Revisited: A Reply." *J. Regional Sci.* Vol. 13, No. 1, 1973.
- (7) Creamer, Daniel, "Shifts of Manufacturing Industries." *Industrial Location and Natural Resources*. U.S. Govt. Print. Off., Wash., D.C., 1943.
- (8) Floyd, C. F., and C. F. Sirmans. "Shift and Share Projections Revisited." *J. Regional Sci.* Vol. 13, No. 1, 1973.
- (9) Hellman, Daryl A. "Shift-Share Models As Predictive Tools." *Growth and Change*. Vol. 7, No. 3, 1976.
- (10) Houston, David B. "Shift and Share Analysis: A Critique." *So. Econ. J.* Vol. 32, 1967.
- (11) Klaassen, L. H., and J. H. P. Paellinck. "Asymmetry in Shift and Share Analysis." *Regional and Urban Econ.* Vol. 2, No. 3, 1972.
- (12) Malizia, Emil. "Standardized Share Analysis." *J. Regional Sci.* Vol. 18, No. 2, 1978.
- (13) Perloff, Harvey S., Edgar S. Dunn, Jr., Eric E. Lampard, and Richard F. Muth. *Regions, Resources and Economic Growth*. The Johns Hopkins Univ. Press, Baltimore, MD, 1960.
- (14) Zimmerman, Rae. "A Variant of the Shift and Share Projection Formulation." *J. Regional Sci.* Vol. 15, No. 1, 1975.

Economies of Scale in Cottonseed Processing

By R. McFall Lamm, Jr.*

INTRODUCTION

Decreasing numbers of firms in food processing industries are frequently considered as evidence of expanding market power. Declining firm numbers generally occur, however, in industries where firms face positive scale economies, or where technical change permits cost reduction. Regulatory economists argue that social benefits from the realization of scale economies or from technical change have been exhausted for most industries and that declining firm numbers result principally from market power. One proposed solution calls for Government intervention to maintain firm numbers at levels greater than would otherwise result. Thus, for industries in which firm numbers are declining, the level of firm scale economies is important in determining whether declines in firm numbers result from natural competitive processes or from the exercise of market power by some firms in the industry.

THE PROBLEM

Over the last 20 years, firm and plant numbers have greatly declined in the domestic cottonseed processing industry. This decline is usually

Over the last two decades, the number of U.S. cottonseed processing plants has declined drastically. The realization of scale economies by expanding plant size is shown to be a basic reason for this decline. The analysis is performed by estimation of a nonhomothetic translog cost function to represent the industry structure. Statistical tests indicate that the translog function is appropriate. Other results indicate that derived demands for inputs in cottonseed processing are inelastic and that economies of scale are greater for smaller plants in the industry.

Keywords:

*Cottonseed processing
Translog cost function
Scale economies*

attributed to the realization of positive scale economies. A study by Stuart and Morrison (9), indicating positive scale economies for soybean processing plants, is frequently referenced as evidence of scale economies in cottonseed processing because of the similarity of the two production processes.¹ No one has attempted to determine the nature of economies in cottonseed processing, however.

THE OBJECTIVES

The domestic cottonseed processing industry was studied to determine whether scale economies exist, and results are presented in this article. Economies are measured by estimating translog cost functions through use of classified ESCS data for individual firms in the industry. The translog functional form allows

estimation of nonhomothetic and nonhomogenous cost functions, and it provides a means for determining derived demand price elasticities.

Characteristics of the cottonseed processing industry are examined and evidence presented on the decline of firm numbers. Next, the postulated decision process assumed to underly the construction of the model is explained, and followed by the model specification. Data used, the results, and conclusions complete the article.

THE INDUSTRY

Cottonseed processing, a multi-million dollar industry in the United States, employs thousands of people and produces four major products—cottonseed linters, cottonseed oil, cottonseed hulls, and cottonseed meal. These products are produced in processing plants generally referred to as cottonseed oil mills because the oil provides the major share of the revenue. Most of these plants are located in the major cotton producing areas of the country.

Uses

Better grades of cottonseed linters form the stuffing material in mattresses, pads, and cushions. Lower grades, referred to as "second cuts," are a source of cellulose. After being refined, cottonseed oil becomes an ingredient in cooking oil, shortening, margarine, and other foods. The hulls are used as a roughage ingredient in animal feeds, and the meal constitutes a protein source in feeds.

*The author is an agricultural economist in the Commodity Economics Division, ESCS. Opinions presented to do necessarily represent those of USDA. Assistance of Elmer Purdue and Stan Thurston in obtaining data is gratefully acknowledged, as are Roger Spindler's research assistance and comments of Duane Hacklander and the reviewers.

¹ Italicized numbers in parentheses refer to items in References at the end of this article.

"Although some decline would be expected, given decreasing cotton production, the drop in plant numbers has been much greater than would have been necessary to compensate for decreased production."

Output and Structure

Annual domestic cottonseed production depends on the level of cotton production. Over the last 20 years, production has fallen gradually because of foreign competition and increased use of manmade fibers. The number of firms processing cottonseed has similarly declined (8). A substantial drop occurred from 1952 through 1972 (10). Although some decline would be expected, given decreasing cotton production, the drop in plant numbers has been much greater than would have been necessary to compensate for decreased production. Consequently, the average size of cottonseed processing plants has increased over time.

From 1954 to 1972, the number of plants in the industry declined from 286 to 115 (table 1). Cottonseed

increase in size of over 300 percent in 18 years, approximately 17 percent per year.

POSTULATED DECISION PROCESS

In the study, cottonseed processors were assumed to maximize profit subject to a multi-output, multi-input production function. Because cottonseed products are jointly produced, one product can be isolated for study to simplify the analysis. With input levels as the relevant decision variables, profit maximization yields rules for optimum input decisions. Substituting these optimal decision rules into the firm profit identity under competition yields the cost function:

$$c = \phi(q, r) \quad (1)$$

where c is total cost, q is scalar output, and r is a vector of input prices.

For the cottonseed processing industry, q represents cottonseed oil output—the cottonseed product generating the largest percentage of total revenue. Cottonseed (m), labor (w), and capital (k) are the inputs considered.³ Because the oil generally is sold to regional food processors with specialized needs and because transportation costs are relatively high, q is largely predetermined. In addition, sales offices usually decide on output levels, but typically do not make the actual production decisions. Given q , the plant managers attempt to minimize cost by choosing the appropriate input levels. Consequently, the postulate of predetermined q seems reasonable. If q is not predetermined, a solution to the firm's decision problem yields $c = \phi(p, r)$, where p is a vector of output prices, which implies that relation (1) is misspecified.

³ One could also eliminate cottonseed input as a decision variable, using an identity to relate oil production to oilseed input. This would be equivalent to assuming perfectly inelastic input demand for oilseeds and zero partial elasticities of substitution between oilseeds and other inputs. In the approach used here, a more general one, these restrictions are not imposed arbitrarily.

Table 1—Selected industry statistics, selected years, 1954-72

Year	Number of plants	Per plant		
		Oil output	Employees	Production workers
		Mil. lbs.	Number	
1954	286	3.52	47.8	38.7
1958	214	6.71	39.0	29.5
1963	188	10.33	44.5	34.9
1967	150	7.38	36.0	28.0
1972	115	11.24	48.7	39.1

Source: U.S. Department of Commerce. *Census of Manufactures*.

oil output per plant (a measure of plant size) increased from 3.52 million pounds to 11.24 million pounds. Total employment per plant increased slightly, from 47.8 employees in 1954 to 48.7 in 1972.²

The increase in oil output per plant represents an

² Cottonseed production and crushings reached their lowest level in more than 20 years in 1967, which explains why oil output was low that year.

MODEL SPECIFICATION

To carry out the analysis, relation (1) is approximated as a translog function proposed by Christensen-Jorgenson-Lau (4). This function has been used widely in recent studies to approximate nonlinear forms. It is especially appropriate here because it allows the estimation of nonhomothetic and nonhomogeneous cost functions. Translog cost functions were first applied by Binswanger in a study of agricultural production (2).

The translog form of relation (1) is written as:

$$\ln c = \alpha_0 + \alpha_q \ln q + \sum_i \gamma_{qi} \ln q \ln r_i + \sum_i \alpha_i \ln r_i + 1/2 \sum_{ij} \gamma_{ij} \ln r_i \ln r_j + 1/2 \gamma_{qq} (\ln q)^2 \quad (2)$$

where q is defined as scalar output of cottonseed oil, the α_i , γ_{ij} 's are structural parameters of the cost function, and the logarithms are natural. Symmetry ($\gamma_{ij} = \gamma_{ji}$) is imposed unconditionally. In addition, homogeneity in prices is imposed unconditionally:

$$\sum_i \alpha_i = 1 \quad (3)$$

$$\sum_i \gamma_{qi} = \sum_i \gamma_{ij} = \sum_j \gamma_{ij} = \sum_{ij} \gamma_{ij} = 0 \quad (4)$$

where $i, j = m, k, w$, for cottonseed, capital, and labor input, respectively.⁴

By noting that $c = r'x$, where x is a vector of inputs, it is apparent that $d c/d r_i = x_i$. In this respect:

$$\ln c/d \ln r_i x_i/c = s_i \quad (5)$$

where s_i is the cost share of the i th input. The translog cost function yields the cost share equations:

$$s_i = \alpha_i + \gamma_{qi} \ln q + \sum_j \gamma_{ij} \ln r_j \quad i = m, k, w \quad (6)$$

Requiring (5) to hold unconditionally implies a representation of the cost structure consisting of relation (2) with three cost-share relations of the type specified in equation (6).

The translog cost function is nonhomothetic and nonhomogeneous.⁵ Homotheticity may be imposed by requiring:

$$\gamma_{qi} = 0 \quad i = m, k, w \quad (7)$$

Homogeneity is imposed by requiring that:

$$\gamma_{qq} = 0 \quad (8)$$

In addition, unitary elasticities of substitution may be imposed by restricting $\gamma_{ij} = 0$, in which case the translog function reduces to a Cobb-Douglas form.

Following Christensen and Green (5), the measure of scale economies used in this study is defined as:

$$\sigma = 1 - d \ln c/d \ln q \quad (9)$$

When $\sigma > 0$, economies of scale exist; when $\sigma < 0$, diseconomies of scale exist. For the general nonhomothetic cost function:

$$\sigma = 1 - (\alpha_q + \gamma_{qq} \ln q + \sum_i \gamma_{qi} \ln r_i) \quad (10)$$

When homotheticity is imposed:

$$\sigma = 1 - (\alpha_q + \gamma_{qq} \ln q) \quad (11)$$

When both homotheticity and homogeneity are imposed:

$$\sigma = 1 - \alpha_q \quad (12)$$

⁵ In a homothetic cost function, cost curves in input-price space exhibit disproportionate shifts as output varies. In a homogeneous cost function, cost curves in input-price space exhibit proportionate shifts as output varies.

⁴ See Binswanger (2, 3) for a discussion.

Nonhomogeneous cost functions yield different scale measures for each size of firm, while the homogeneous scale measure (12) yields one value for all sizes of firms in the industry.

THE DATA AND ESTIMATION PROCEDURE

The classified ESCS data used in the study came from a combined time-series, cross-section sample collected over a 20-year period. Because scale economies must be distinguished from technical change, an intertemporal phenomena, cross-sectional data must be used to estimate the industry structure. Unfortunately, degree of freedom limitations prohibit the use of any single cross section from the sample.

As an alternative, two combined time-series, cross-sectional data sets were selected from the sample. The first, data set I, consists of 44 firm observations from 1960, 1961, and 1962. Close inspection of detailed data on these firms indicated that they had neither added to existing facilities nor replaced existing technologies with new technologies during 1960-62. For practical purposes then, little or no identifiable technical change occurred in the data set. The second, data set II, consists of 39 firm observations from 1972, 1973, and 1974.⁶ Again, careful examination of the firms indicated little evidence of technical change.

Except for capital costs, all data varied cross sectionally by firm. Cottonseed prices (dollars per ton) were obtained directly from the classified ESCS source. The price of capital was proxied simply as the rate on corporate AAA bonds. Wage rates (dollars per year) were obtained from census data for each State. Total cost (dollars per year), cottonseed oil output (pounds), and the input data necessary to compute cost shares, also came directly from ESCS classified sources.

The cost structure system was estimated with the iterative Zellner procedure used by Christensen-Green (5), Griffin (6, 7), and Berndt-Christensen (1) to estimate similar systems. This procedure, which

converges to maximum likelihood estimates, requires that one cost-share equation be dropped from the system to obtain nonsingularity in the variance-covariance disturbance matrix.⁷

Because the iterative Zellner procedure converges to maximum likelihood estimates, the likelihood ratio test may be used to test for homotheticity and homogeneity (functional form). The relevant test statistic, as described by Christensen-Green (5), is:

$$\lambda = (|\Omega_c|/|\Omega_u|)^{-n/2} \quad (13)$$

where λ is the value of the likelihood ratio, $|\Omega_c|$ is the determinant of the conditionally constrained (homothetic or homogeneous) variance-covariance matrix, $|\Omega_u|$ is the determinant of the unconstrained (nonhomothetic) variance-covariance matrix, and n is the number of observations. Tests were performed by using the fact that $-2 \ln \lambda$ has a chi-square distribution with degrees of freedom equal to the number of conditional constraints imposed on the system.

RESULTS OF ESTIMATION

Three forms of the translog cost function were estimated for each data set. The first, model A, consists of the system represented by relations (2) and (6), the nonhomothetic form. The second, model B, consists of the system represented by relations (2) and (6) with conditional constraint (7) imposed. This is the homothetic form. The third cost function estimated, homogeneous in output and referenced as model C, consists of the system represented by relations (2) and (6) with conditional constraints (7) and (8) imposed. The cost-share equation for labor is omitted to allow estimation of each model.

Iterative Zellner estimates of all three models for each data set appear in table 2. The α_i parameters are somewhat sensitive to model specification, much more so than the γ_{ij} substitution parameters. The α_q is especially

⁶ These years were chosen based on the number of firms included in each year's data.

⁷ Pooled data are treated as independent observations.

Table 2—Estimates of cost function parameters

Parameter	Data set I			Data set II		
	A	B	C	A	B	C
α_0	1.244 (5.747)	2.244 (7.035)	-5.041 (.551)	-3.967 (4.838)	-3.240 (4.855)	-4.202 (.835)
α_q	.215 (.666)	.113 (.817)	.967 (.021)	.883 (.576)	.872 (.578)	.985 (.029)
α_m	.664 (.097)	.794 (.078)	.796 (.079)	.612 (.124)	.761 (.044)	.762 (.044)
α_k	.184 (.785)	.116 (.890)	.116 (.811)	.356 (.207)	.458 (.214)	.456 (.215)
α_w	.152 (.062)	.090 (.059)	.088 (.059)	.031 (.193)	-.219 (.211)	-.217 (.211)
γ_{qq}	.023 (.019)	.024 (.023)		.004 (.017)	.003 (.017)	
γ_{qm}	.009 (.004)			.009 (.005)		
γ_{qk}	-.003 (.003)			.001 (.005)		
γ_{qw}	-.007 (.002)			-.010 (.003)		
γ_{mm}	.102 (.014)	.103 (.016)	.104 (.016)	.061 (.008)	.061 (.008)	.061 (.008)
γ_{mk}	-.122 (.023)	-.129 (.024)	-.130 (.024)	-.080 (.012)	-.080 (.012)	.080 (.012)
γ_{mw}	-.082 (.013)	-.078 (.015)	.078 (.015)	-.043 (.007)	-.042 (.009)	-.042 (.009)
γ_{kk}	.038 (.349)	.038 (.346)	.038 (.596)	.042 (.014)	.048 (.016)	.048 (.017)
γ_{kw}	.047 (.011)	.052 (.012)	.053 (.012)	.004 (.027)	.016 (.032)	.016 (.032)
γ_{ww}	.017 (.005)	.013 (.005)	.013 (.005)	.024 (.013)	.029 (.015)	.029 (.016)

Note: Estimates are maximum likelihood; standard errors appear in parentheses below each estimated coefficient. The subscripts are defined as follows. 0 represents the intercept term, q denotes output, m is cottonseed input, k is capital input, and w is labor input.

sensitive; it changes value considerably when homogeneity is imposed on the system. Because some of the estimated parameters of each model are not highly significant statistically, it is not apparent which of the three models is preferable and acceptable for describing the industry.

A decision concerning acceptability is possible by using the χ^2 test described previously. Table 3 presents values of the test statistic $-2 \ln \lambda$. In each case, model A is taken as the unconstrained form to compute $|\Omega_u|$, and

$|\Omega_c|$ is computed with models B and C. Because the computed χ^2 statistics are greater than the critical level with 99-percent confidence, the homothetic and homogeneous forms can be rejected for both data sets. The nonhomothetic form of the cost function appropriately represents the industry structure.⁸

Second-order conditions require that the cost function be monotonic and convex in input-price space. These conditions are satisfied if the fitted $s_{ij} > 0$ $i = m, k, w, j = 1, \dots, n$, and the relevant bordered Hessian is negative definite. These conditions are satisfied for all model A observations in both data sets.

Mean estimates of scale economies are presented in table 4 for five groups of firms ranked by output from smallest to largest. For each estimate, t statistics appear in parentheses for the null hypothesis that mean $\sigma = 0$. For both data sets, significant scale economies (t statistics greater than 2, positive values for σ) are

⁸ Additional testing of model A against nonhomothetic, and homogeneous Cobb-Douglas cost functions indicated the acceptance of this model.

Table 3—Test statistics for homotheticity and homogeneity

Test	Hypothesis	
	Homotheticity	Homogeneity
Restrictions	2	3
Critical χ^2 (1%)	9.21	11.35
χ^2 Data set I	38.28	40.30
χ^2 Data set II	15.795	16.068

Table 4—Estimated firm scale economies

Size class	Data set I				Data set II			
	$\bar{\sigma}_a$	$\bar{\sigma}_b$	$\bar{\sigma}_c$	$\bar{q}$	$\bar{\sigma}_a$	$\bar{\sigma}_b$	$\bar{\sigma}_c$	$\bar{q}$
1	0.073 (20.23)	0.094 (23.34)	0.033 (1.57)	8.3	0.028 (11.50)	0.026 (16.54)	0.016 (.55)	5.5
2	.055 (26.46)	.073 (29.07)	.033 (1.57)	12.0	.020 (14.15)	.020 (56.6)	.016 (.55)	11.8
3	.042 (42.30)	.062 (47.25)	.033 (1.57)	16.1	.018 (14.99)	.018 (119.94)	.016 (.55)	16.0
4	.031 (25.71)	.048 (17.34)	.033 (1.57)	20.0	.017 (11.97)	.016 (112.49)	.016 (.55)	20.1
5	-.012 (1.26)	-.003 (.39)	.033 (1.57)	60.4	.008 (2.97)	.010 (5.41)	.016 (.55)	65.2

Note: Oil output is in million pounds, and t -statistics are in parentheses. Subscripts refer to models, and bars denote mean values.

"... at least partially, the cause of declining firm numbers in the cottonseed processing industry is due to the realization of firm economies within the industry."

indicated for size classes 1 through 4, when the cost function is nonhomogeneous. When homogeneity is imposed, however, no significant scale economies are indicated. Thus, model specification is crucial in determining whether scale economies exist.

Based on group estimates of σ , the largest scale economies exist for the smallest size class of firms for both data sets. For example, using the nonhomothetic form, the value of σ is 0.073 for the smallest size class of data set I. For data set II, the corresponding value is 0.028. As size classes get larger, σ values decline, which indicates less opportunity for reducing average costs by expanding firm size. This behavior conforms to prior expectations. On an intertemporal basis, opportunities for scale economies decreased from 1960-62 through 1972-74, even for smaller sized firms. Even so, significant unexploited scale economies existed in 1972-74.

Given the estimates of the γ_{ij} in table 2, derived demand price elasticities for inputs were obtained using the relation:

$$\eta_i = (\gamma_{ii} + s_i(s_i - 1))/s_i^2 \quad i = m, k, w, \quad (14)$$

where η_i is the derived demand price elasticity for the i th input (5). Derived demand price elasticities were computed for cottonseed, capital, and labor used in cottonseed processing (table 5).

The reported derived demand elasticities for all three inputs by size class and data set are all inelastic. This finding is consistent with prior expectations—in highly specialized plants, inputs are demanded with little sensitivity to price. In this respect, the demand for cottonseed is more inelastic than the demand for capital or labor. Firm size has only a limited effect on the level of derived demand elasticities, across size classes, except perhaps for the derived demand for labor in 1972-74. From 1960-62 to 1972-74, derived demands for capital and labor become more inelastic while the converse was true for cottonseed. This behavior is con-

Table 5—Derived demand elasticities

Size class	1960-62			1972-74		
	$\bar{\eta}_m$	$\bar{\eta}_k$	$\bar{\eta}_w$	$\bar{\eta}_m$	$\bar{\eta}_k$	$\bar{\eta}_w$
1	-0.09	-0.59	-0.73	-0.15	-0.50	-0.48
2	-.06	-.57	-.73	-.12	-.50	-.45
3	-.07	-.59	-.73	-.11	-.48	-.38
4	-.06	-.57	-.72	-.13	.51	.38
5	-.07	-.58	-.71	-.13	-.50	-.37

sistent with increased plant specialization in capital and labor use, and greater efficiency in production scheduling in cottonseed use.

CONCLUSION

With the potential of increasing cotton production in the years ahead, cottonseed processing will become more important. Over the last 20 years, the number of firms and plants in the industry declined considerably. This has raised concern among many economists that market power might be increasing in the industry.

Based on the acceptance of a nonhomothetic cost function, results indicate that, at least partially, the cause of declining firm numbers in the cottonseed processing industry is due to the realization of firm economies within the industry. This process is most likely a consequence of effective competition, although it is not clear why unexploited scale economies have persisted over time.

Further, the cost structure of the industry is nonhomothetic, input demands are inelastic, and they vary little by firm size. Because of the similarity in the level of measures of scale economies for different size classes, the "flat" region of the average cost curve for firms in the industry is lengthy. Thus, the cottonseed processing industry exhibits a considerable dispersion in firm size.

REFERENCES

- (1) Berndt, E., and L. R. Christensen. "The Translog Function and the Substitution of Equipment, Structures, and Labor in U.S. Manufacturing 1929-68." *J. Econometrics*. Vol. 1, 1973, pp. 81-113.
- (2) Binswanger, H. P. "A Cost Function Approach to the Measurement of Elasticities of Factor Demand and Elasticities of Substitution." *Am. J. Agr. Econ.* Vol. 56, 1974, pp. 377-386.
- (3) ———. "The Measurement of Technical Change Biases with Many Factors of Production." *Am. Econ. Rev.* Vol. 65, 1974, pp. 964-976.
- (4) Christensen, L. R., D. Jorgenson, and L. J. Lau. "Conjugate Duality and the Transcendental Logarithmic Production Function." *Econometrica*. Vol. 39, 1971, pp. 255-256.
- (5) Christensen, L. R., and W. H. Green. "Economies of Scale in U.S. Electric Power Generation." *J. Polit. Econ.* Vol. 84, 1976, pp. 655-676.
- (6) Griffin, J. M. "The Econometrics of Joint Production: Another Approach." *Rev. Econ. and Statis.* Vol. 59, 1977, pp. 389-397.
- (7) ———. "Joint Production Technology: The Case of Petrochemicals." *Econometrica*. Vol. 46, 1978, pp. 379-397.
- (8) National Cottonseed Products Association. *The International Green Book*. The Cotton Gin and Oil Mill Press, Dallas, TX, issued annually.
- (9) Stuart, C., and W. R. Morrison. "Economies of Size in Soybean Processing Plants," Agr. Expt. Sta., Univ. Ark., Bull. 743, Fayetteville, 1969.
- (10) U.S. Department of Commerce. *1972 Census of Manufactures*. U.S. Govt. Print. Off., Wash., D.C., 1974.

In Earlier Issues

The rapid growth of the population of the United States during the last decade, together with the wider use of statistics relating to the future, have brought about an increase of interest in population projections . . . No official attempt has been made to publish periodically a systematic set of projections for the major geographic subdivisions of the United States . . . Fertility and mortality occur with more statistical regularity than does migration, and to the extent that they do they are more predictable. Because of this, it seems reasonable to conclude that projec-

tions of the total population of the United States can be made with more accuracy than projections for geographic subdivisions of the country. [Hagood and Siegel accepted census projections to 1975 of the U.S. population and projected the distribution among the nine census divisions. Their widest relative error was an underestimate by only 1.35 percent of the share that would be in the South Atlantic region in 1975. (ed.)]

Margaret Jarman Hagood
& Jacob S. Siegel
April 1951, Vol. 3, No. 2, pp. 41-52.

Research Review

THE LESSONS OF WAGE AND PRICE CONTROLS— THE FOOD SECTOR

Dunlop, John T., and Kenneth J. Fedor, editors, Harvard University Press, Cambridge, Massachusetts, 1977, 344 pages, \$19.50.

*Reviewed by Abner W. Womack**

For those interested in analyzing the impacts of the wage and price controls lasting from August 15, 1971, to April 30, 1974, this book is essential. It provides behind-the-scene interactions, reactions, and counteractions between key Government agencies and industries, and a careful chronology of events. We are fortunate that these authors took the time to set down their experiences with wage and price controls. Five of the six authors were with the Cost of Living Council during the control period, and each reflects areas of responsibility and professional background. The reader finds areas of overlap and varying conclusions drawn, but, in most cases, the story is much the same: Controls are difficult to manage in the food sector. Complete controls would require a substantially greater number of Government employees to monitor all segments of the industry from the farm to the retail market. If the Administration settles for a piecemeal program, industry and Government will find themselves acting and reacting to economic events guided by structure, expectations, and economic incentives that do not conform to models and intuition based on periods without control.

Given this unsettling information, one wonders why the whole matter of controls would not be dismissed

and more viable alternatives considered. But the notion is often very popular; as we reach periods of relatively high food prices, popular pressures for controls are likely to surface again. This book can be considered one of the best sources of information on structural adjustments that are likely if similar controls are adopted in the future.

In chapter one, "Agricultural Development," author Glenn Nelson reminds us that Freeze I, August 15, 1971, to November 13, 1971 was a three-pronged attack on rapid inflation, a balance-of-payment deficit, and high unemployment. For each of the five control stages, Nelson examines the announced policy, the state of the general economy, the feed grain-livestock sector, wheat, protein meals, and dairy products. He provides insight on how the food economy reacts to ceilings on retail prices when raw product prices are unconstrained. We see how processors are squeezed out of business, and how the Administration attempts to readjust with cost-passthrough provisions.

Of particular interest is the author's discussion of constraining beef prices while other meat prices were allowed to seek free-market equilibriums. If his interpretation is correct, researchers will find that a quantification of supply response for beef products during this period, at the farm level, will demonstrate a structural change relating to price information. At a time when hog and poultry producers were cutting back production, beef producers interpreted the freeze to imply a bottom price. Producers passed up profitable prices only to lose heavily after the freeze was rescinded. Not surprisingly, forecasting models of the U.S. Department of Agriculture and other Government agencies did not predict

this turn of events.

Behind-the-scene accounts are given of displeasure with USDA policies. Marketing guides designed to support egg and poultry prices, and the announcement in December 1972 of a 25-million acre set-aside program for 1973 feed grains in the face of higher prices, were cited as being out of step with the overall goals for curbing inflation and lowering food prices. A special food committee of the Cost of Living Council, chaired by Secretary of the Treasury Shultz and including Secretary of Agriculture Butz, was created to stimulate greater emphasis on consumer interests. USDA was viewed by other Government agencies as being biased towards maintaining higher farm prices; thus, as pointed out by Nelson, its ability to fight successfully on policy issues was rapidly eroding.

In chapter two, "The Agribusiness Market Structure and Controls," author Ray Goldberg reviews the agribusiness background, particularly the significance of a relatively stable farm price in conjunction with excess supplies. He provides a rather detailed description of the freeze implications on the beef industry. The reader is led through the relatively stable period of Freeze I and Phase II up to the more unstable period covering Phase III and Freeze II, January 11, 1973, to July 18, 1973, by which time retail beef prices had moved up 18 percent. These higher prices precipitated a ceiling price of beef set at the end of March 1973. Goldberg hypothesizes that beef cattle producers perceived the ceiling price to be a floor and modified production decisions accordingly. But this withholding strategy occurred at a time when the beef price cycle was coming to a peak. Thus, an attempt by the

*The reviewer is an economist in the Commodity Economics Division, ESCS.

Administration to curb price increases had a perverse effect on the industry and accentuated the problem.

Goldberg concludes that the programs under which the agriculture sector had been operating for 25 years should have been examined more closely for desired response in lieu of imposing new constraints.

Kenneth J. Fedor and Reginald J. Brown wrote chapter three, "The Design and Implementation of Food Price Regulations." They address two questions: (1) To what extent should the regulations limit price increases by forcing firms to absorb rising costs; and (2) to what extent should all segments of an industry be controlled? Several arguments are given on the economic shortcomings of a food price freeze. Prices set below equilibrium levels imply rationing, which ultimately requires large numbers of Government employees; if the freeze is short term, this procedure is not acceptable. It is difficult to regulate prices of raw agricultural products. Since raw products were considered to nearly reflect free market prices, and the program was perceived to be short term, policymakers omitted price controls for raw products. The authors examine the fallacy of this decision in substantial detail.

Fedor and Brown also treat the economics of cost passthroughs that were allowed in Phase IV, July 19, 1973. Subjects include: allowable costs, formulas for cost passthrough, special regulations for retailers and wholesalers, base periods for determining customary initial percentage markup, and category versus item control. They conclude that the anti-inflation programs in the food/agriculture area should have been limited to changes in existing Government programs.

Wage stabilization aspects of

price and wage regulation receive attention in chapter four, "Wage Stabilization in the Food Industry," written by William M. Vaughn, III. He particularly notes the experience of the Tripartite Food Industry Wage and Salary Committee. Vaughn looks at issues associated with previous wage and price controls and at committee experience based on problems confronted during the period under consideration. Lessons learned he summarizes in a section appropriately titled: "Costs and Benefits, Lessons Learned, and Open Questions."

A sobering point concerns the amount of startup time and personnel necessary. Combining this with the need for cooperation among affected parties leaves one with the impression that a program aimed at shortrun controls will be severely constrained from the start. Two important questions are debated: (1) Do price controls necessitate wage controls and (2) does a wage control program need strong compliance. Voluntary compliance may actually be viable.

Chapter five, "International Food Policy Issues," is also written by Glenn Nelson. He examines international policy from the perspective of domestic food prices. Numerous charts and graphs present characteristics of the international markets including natural phenomena, social and political institutions, cycles of economic growth and recession, shifting exchange rates, foreign agriculture and food policies, state trading arrangements, and expected future trends. These major issues lead to the question of a reserve program with all of its economic ramifications, a choice that the United States would seem forced to make because of the international environment. Nelson points out that our open economy

takes on an undue share of the changes in the supply-demand balance in the world markets.

The first five chapters are summarized and additional insights provided in chapter six, "Lessons of Food Controls, 1971-74," written by John Dunlop. He warns the reader about the implications of a controls program remaining in effect too long, and the merits of considering one that concentrates on nonfood items and leaves the relatively competitive agriculture market to seek equilibrium. He maintains that control programs become confusing to all parties as time goes on. During the 35-month period, we experienced two different freezes and three phase modifications. Getting out of controls can be much more difficult than getting in, he cautions.

Dunlop attempts to disentangle the economics of short supplies and increased exports from the popularly held concept of controls. The latter can overpower the former; a case in point is the freeze placed on meat prices by President Nixon in the spring of 1973. Dunlop attributes motivation for this action as a reaction to the popular attitude that profits in the food industry were responsible for high prices. Unfortunately, the President over-rode his economic advisors and bowed to these popular and more political pressures.

I suggest that readers of this book remember a statement attributed to Professor Willard Cochrane, that, in making economic policy decisions, we must consider the political equilibrium as well as the economic equilibrium. My problem in grasping the main theme of the book was related to this point. I continued to read from an economic standpoint and did not zero in on this political
(Continued on page 36)

... AND THE DESERT
SHALL REJOICE:
CONFLICT, GROWTH
AND JUSTICE IN ARID
ENVIRONMENTS

Arthur Maass and Raymond C. Anderson. MIT Press, Cambridge, Mass. 447 pages. 1978. \$19.95.

WATER PRODUCTION
FUNCTIONS
FOR IRRIGATED
AGRICULTURE

Roger W. Hexem and Earl O. Heady. Iowa State University Press, Ames, Iowa, 215 pages. 1978. \$8.95.

SELECTED WATER
MANAGEMENT ISSUES
IN LATIN AMERICAN
AGRICULTURE

Pierre R. Crosson, Ronald G. Cummings, and Kenneth D. Frederick, editors. Published for Resources for the Future by the Johns Hopkins University Press, Baltimore and London, 190 pages. 1978. \$14.95.

*Reviewed by Harry W. Ayer**

The unifying theme of these books is the economics of irrigation. They vary greatly, however, in the specific problems and decision level treated (farm, irrigation district, large region), location (a variety of regions within several countries) and analytic methods employed (basic production function methodology, simulation, linear programming, and others). Overall, the three books are of high quality. All will interest researchers working with the economics of irrigation at the aggregate level. The Hexem and Heady book could be used as a supplementary text in a production economics course. The books by Maass and Anderson, and Crosson, Cummings, and Frederick also have merit for water policy-makers. The single greatest shortcoming of these books, and of the existing literature on the economics of irrigation, is that they fail to specify adequately the micro-level water-crop production function for on-farm decisions.

... AND THE DESERT
SHALL REJOICE ...

Maass and Anderson study six irrigated settlements—three in Spain, and three in the United States. Their purpose is formidable: "... to understand the (water) institutions and procedures, to discover the objectives, and to evaluate the institutions and procedures in terms of how well they satisfy the communities' goals." They accomplish their purpose

*The reviewer is an agricultural economist in the Natural Resource Economics Division, ESCS, and adjunct associate professor, University of Arizona, Tucson.

admirably. In so doing, they provide a framework and methodology, and draw important policy conclusions for future economic research and policy on irrigation.

For each irrigation settlement, the physical setting (including location, climate, crops, farm size, land ownership, topography, water volumes, and sources) is detailed carefully, and the physical features are related to the history of rules which govern water use in the area. The controlling and regulating institutions are described faithfully—which interest groups are in control, what operating procedures exist for decisionmaking, who the key personnel are and what are their duties, how expenses are met, and how procedures are enforced.

For economists, a focal point is the simulation model used to evaluate the effects of alternative water use rules imposed on or by the irrigation district. Unfortunately, the model is described only briefly, and the reader is referred to the authors' previously published bulletin. The model is based on budget data for each of 10 representative farms of each region and on the decision rules which allocate the region's water among farms. The model selects that combination of crops and water use, by 2-week intervals during the growing season, which maximizes net revenues. Operating procedures (when and how much to irrigate each crop) can be altered throughout the growing season in response to changing water availability. Results indicate for each farm the acreage of each crop, the amount and sequence of water application, and total revenues, total costs, and net revenues. Researchers can use the model to evaluate the impact on production, revenue, and water use of alternative water allocation rules—such as

distributing water based upon the proportion of the region's total acreage owned by a particular farm—and the impact of new irrigation facilities—such as a reservoir to eliminate seasonal water shortages.

A shortcoming of the model (and most economic models of irrigation) is that the underlying production function which specifies crop response to irrigation water is only very roughly specified. It is assumed that water may be applied at specified intervals, and that water scarcity is reflected by omission of one or more entire water treatments, rather than by use of a lesser amount during an application period. Thus, irrigation is assumed to be a very discrete, all-or-nothing, operation within periods.

The authors derive guidelines for regional water policy from the study. Three of the most important and broad pertain to the 160-acre limitation, the ability of local irrigation districts to control water which is supposedly under considerable large-region or central government control, and the equity of the distribution of net benefits derived from alternative

(Continued from page 35)

theme until chapter three. Because this chapter covers initial groundwork necessary to appreciate particular controls programs, it would have been better if it had been first.

The book succeeds in adhering to the intended subject: "Lessons learned." It contains numerous insights into quantification of economic events during 1971-74, and should prove invaluable for the researcher in the food, labor, and other related industries. For the policymaker faced with pressure to curb high food prices, this book should serve as a grim reminder that controls can have perverse effects.

water policies. The Maass-Anderson study was completed before the current debate over the 160-acre limitation rule, but they provide historical information which is "must" reading for anyone now concerned. Frequently, communities in arid areas seek local control of water, and, at the same time, the State, multistate region, or Federal Government may desire more control of a region's limited water to internalize externalities. What the Maass-Anderson work demonstrates, for a wide range of geographical and political settings, is that local control has reigned supreme. Finally, the model indicates, contrary to much popular opinion, that rules and institutional arrangements which most closely approximate a market economy for water also provide the greatest degree of equality and equity.

The authors conclude with a thorough, enticing discussion of hypotheses for further research suggested by their study. For example, land speculation and corporate wealth may have an impact on regional agricultural development. Data from their work can also be used, they suggest, to investigate the impact of uncertainty on irrigation decisions at all levels.

WATER PRODUCTION FUNCTIONS FOR IRRIGATED AGRICULTURE

Hexem and Heady focus on the estimation and application of water production functions for the Western States. Their work was prompted by the U.S. Bureau of Reclamation which needs underlying, basic crop-water response information to provide an economic rationale for its proposed programs.

The authors provide an overview of production economics principles and the statistical procedures used to estimate crop-water production functions empirically. They treat the theory compactly, yet adequately as to the key variables, optimizing criteria, and functional forms used in basic production function analysis. They use graphs and basic calculus effectively to illustrate the physical and economic principles involved. They also provide basic information on experimental design and the estimation of parameters through regression analysis (OLS) and associated statistical tests.

The production functions were estimated from experiments conducted in Arizona, California, Colorado, Kansas, and Texas from 1967 through 1972 by agricultural experiment station staff. For each crop—corn, wheat, corn silage, cotton, and sugar beets—both irrigation and nitrogen fertilizer levels were varied, and other factors of production were held fixed within sites. Among sites, both weather and soil factors varied, and generalized production functions over sites attempted to account for these variables.

The heart of the book is a crop-by-crop, State-by-State presentation of the "best" production function estimates. In each case, empirical estimates of one or more production function forms are given, along with tests of significance and R^2 's. Marginal product curves and isoquants plus graphs of the total, marginal, and isoquant functions are given for each crop, but not for each site. Generally, the estimated functions relating yield to annual applications of water and fertilizer fit the data rather well. R^2 's are typically greater than 0.7 and the key variables are often significant with the

expected sign. The generalized production functions, which account for soil (pH, electrical conductivity, and other factors) and weather (pan evaporation) differences among sites, also produced high R^2 's, but individual parameter estimates were not always as expected. Essentially no economic analysis is provided.

Potential use of crop-water production functions in economic analysis and policy formation is described, however. The authors draw upon an empirical study of two watersheds in central Utah. Crop-water production functions were incorporated into a linear programming model of representative farms of the region. By varying water price, the Utah analysts estimated the demand for water in both regions. In the aggregate model, they allocated water by the water conveyance system between the regions and through time so that consumer surplus to the regions was maximized. Policy implications can be drawn concerning the efficiency of the dam and delivery system of the area, and the method of operating the system. Although short, this treatment illustrates for policy analysts the usefulness of crop-water production functions, and the authors suggest research methodology for persons conducting economic studies.

Data used in making the production function estimates, and other tabular material appear as microfiche inserts in the book.

Persons concerned with regional (versus on-farm) water policy in the West can use material in the book. Agronomists would also benefit from the section on experimental procedures and data needs for economic analysis of crop response to irrigation. Graduate students studying production economics will find this book a good supplemental text in

treating production theory, statistical analysis, and application of the theory and statistics.

SELECTED WATER MANAGEMENT ISSUES IN LATIN AMERICAN AGRICULTURE

Crosson, Cummings, and Frederick present papers on a variety of water problems in agricultural areas of Latin America. Several economic empirical methodologies are employed to analyze a number of policies and projects intended to make more efficient use of scarce water. The editors' objectives are to improve water policy in Latin America and elsewhere, and to provide methodological ideas for those conducting research on the economics of irrigation. In general, the presentations are convincing and deserve the attention of both those who study and those who formulate water policy.

The editors provide a sharp review of problems and policy in irrigated areas, effectively using the papers presented and other literature also. They consider factors affecting the efficiency of investments in water control projects and the efficiency of water management. Timing, regional location, and project design affect investment efficiency. Management efficiency is determined by the time path of use of stored water, political interests which determine the distribution of water between farm and nonfarm sectors, and policies which determine the price of water to the agricultural sector and the distribution of irrigation water between leaching of salts and direct plant uptake.

Seagraves and Ochoa investigate alternative water pricing policies in

Canele, Peru. Most of the country's agricultural production occurs in the desert, coastal areas where rivers, originating in the Andes, feed irrigation canals. Problems associated with the irrigation system include scarcity of water during particular months and flooding during others. To cope with these problems and expand agricultural production, the government is involved in major canal and water storage projects. The authors investigate the economics of the projects and alternative water pricing policies.

They dwell considerably on methodology, and they use linear programming techniques which incorporate both supply and demand equations. They conclude with several policy recommendations, among them proposals pertaining to investment strategies and water fees.

In his study, Frederick focuses on threats to an irrigated grape-wine area of Argentina. The grape-wine industry and local communities depending on the industry are threatened because water use exceeds river flow and ground water recharge. Past and current government policies encourage a socially inefficient allocation of water. Water pricing policies, tax policies, pump energy pricing, and subsidies to grape production all encourage overuse of water in grape irrigation. Out of a largely qualitative analysis, the author draws several policy conclusions.

Cummings and others investigate the economics of allocating water between shrimp lagoons and crop irrigation in northwestern Mexico. The model used is a chance-constrained stochastic, dynamic program and it includes a biological model of shrimp production. Besides illustrating the use of a rather complex methodology, the authors reveal, perhaps

surprisingly, that shrimp production competes economically with irrigated agriculture for substantial quantities of scarce water.

In McFarland's study on water scarcity and salinity in northern Mexico, he indicates that the underground water table has fallen and sea water has intruded into the aquifer as farm use of irrigation water has expanded. Not only have pumping costs increased, but saline irrigation water also threatens crop yields. Several policies have been proposed to counteract these problems: the introduction of salt-tolerant crops such as garbanzo beans, the installation of artificial drains, and inter-basin transfers of water. McFarland, using a dynamic programming model, investigates the optimum policy and time allocation of water between leaching and direct crop use.

Millan and Mijia, evaluating a multipurpose flood control project in Colombia, attempt in their model to account for the myriad socioinstitutional, economic, and hydrologic interrelationships which often characterize multipurpose flood control projects. They explain portions of the simulation model but refer the reader to another publication for details. They evaluate a flood protection project on the Cauca River of Colombia, but because of weak underlying data, provide only tentative policy conclusions.

Overall, authors of these papers on important water problems refine and demonstrate the use of empirical methodologies which can be applied to similar problems of other geographic areas, and they offer policy conclusions to improve economic efficiency in the areas studied. They provide adequate, compactly presented information for both researchers and those who form policy.

INDUCED INNOVATION: TECHNOLOGY, INSTITUTIONS, AND DEVELOPMENT

Hans P. Binswanger, Vernon W. Ruttan, and others. The Johns Hopkins University Press, Baltimore, Md., 1978, 423 and XIV pages. \$22.50.

*Reviewed by Ted Thornton and
William B. Back**

Induced innovation refers to the study of how prices of factors, products, and other key economic variables interact in determining the rate and direction of technical change, and, consequently, characteristics of economic growth. Rather than regarding innovation as autonomously or exogeneously given, the authors place it within microeconomic theory wherein the nature, rate, and direction of innovation become determined by the economic incentives, decisions, and actions of firms operating in a market economy.

Binswanger, Ruttan, and the other authors provide both a valuable introduction and a rigorous statement of the theory of induced innovation. They also give historical perspective on use of the theory in the United States, Japan, Brazil, and Argentina. The book will appeal to economists and researchers interested in innovation as a variable in microeconomic analysis, and who have sufficient mathematical background to understand and to appreciate the modeling and related refinements in the theory. In particular, the book may appeal to persons beginning research on technology. The authors present straightforward treatments on the divorce of compensation of the innovator from charges to the user of the innovation, publically financed research, patent laws, the

relationship between market structure and technical change, changes in income distribution and factor shares resulting from technical change, technology transfer, and the recent developments in the theory of induced innovation.

The strength of the book lies in the rigorous expression of a theory of induced innovation, made possible by the authors' placing the concept of induced innovation within the context of microeconomic theory of the firm. Innovation can thus be studied with the traditional tools of economic analysis as to its role in the effects of prices and resource availability on the allocation of goods and services. The models presented are manipulated to examine the place of innovation in the firm and to describe innovation in terms of changes in final demand, factor prices, resource availability, and resource allocation over time.

The shortcoming of the book relates to the limitations of microeconomics as a source of criteria for public decisionmaking. Many innovations do not result from economic incentives or forces within a market economy but from government regulation or nonmarket demands. For example, a firm ordered by a government to reduce emissions from a

smokestack will consider economic factors in determining the type of innovation to reduce emissions, but the impetus for innovation did not come from economic forces endogenous to the firm or market. Also, market forces may have little bearing on military innovations, or innovations in public services. The problems of market failure are well known to economists. But just as the market may fail to provide a socially desirable amount of goods and services, it also may fail to provide the innovations that society wants or needs. The induced innovation theory does not account for the wide variety of innovations generated outside the market system. Nor does it account for impacts of technology other than the income effects distributed by market forces. Therefore, the theory presented fails as a criterion for public policy relating to technology and innovations.

Nevertheless, *Induced Innovation* is worthy of professional attention. It will serve as a base for some research on the economic determinants of innovation and the social effects therefrom. The unmet need is for a macroeconomic theory of innovation which can serve as an analytical base for technology assessment.

In Earlier Issues

In the search for wise use of natural resources, too little attention has been given to the watershed, too much to dams and levees on the river.

Review of: *Water, Land, and People* (Bernard Frank & Anthony Netboy)
E. H. Wiecking
April 1951, Vol. 3, No. 2, p. 61

*The reviewers are agricultural economists in the National Economic Analysis Division, ESCS.

ENVIRONMENTAL IMPROVEMENT THROUGH ECONOMIC INCENTIVES

Frederich R. Anderson, Allen V. Kneese, Phillip D. Reed, Serge Taylor, and Russell B. Stevenson. *Resources For the Future*, The Johns Hopkins University Press, 195 pages, 1977. Cloth, \$13.00; Paper, \$4.50.

*Reviewed by David Wilson**

This book was written for persons concerned with environmental management strategies. It will be especially useful for all legislators, agency personnel, political scientists, economists, planners, engineers, and attorneys involved in developing environmental policies and controls. The authors treat the interdisciplinary nature of protecting the environment by focusing on the economic, technical, legal, and political aspects in different chapters. They have coordinated these aspects reasonably well.

Direct regulation, control, and management of environmentally harmful activities have been inadequate, state the authors. Although the regulatory approach has produced important gains, they conclude, it has also allowed many polluters to avoid being regulated.

Political and economic costs of an effective direct regulation program are seen as being too high. The authors question current regulatory programs, which are costly, cumbersome, and ineffective. If these programs do not produce more results at reasonable prices soon, discouraged legislators will cast them aside. The major problem with regulatory programs is that, in practice, enormous administrative costs are incurred in meeting objectives.

The authors examine the strategy of levying pollution charges instead of, or in conjunction with, direct regulation. Such charges would provide an incentive to discontinue or abate polluting activities. The argument is that pollution standards could be enforced much more easily if an incentive structure existed which would induce firms to choose the most economically efficient abatement alternative.

The primary economic purpose of the environmental charge system is to create new markets that would allocate resources efficiently and produce net benefits to society. The lack of markets is viewed as a major cause of environmental problems. Air and water resources have in the past been used to absorb raw wastes because it has been economically advantageous to do so. Other resources have been subject to market prices and constraints while the use of environmental resources has not been.

The authors point out that many of the political problems related to using a charge system stem from a national preference for direct regulation as the only appropriate legislative means of answering a social need. The market approach, they indicate, will be opposed by industrialists out of self-interest; by regulatory authorities out of fear of failures of current programs; and by politicians who do not want a more publicly visible pollution control strategy. Major policy revisions come only infrequently and only after a number of years for an existing policy to prove itself ineffective.

Use of pollution charges could, the authors believe, increase administrative and economic efficiency and equity. Levying charges for polluting activities is a technique very likely to be much debated and probably tested in the near future. Adoption would form a new category of regulatory legislation, one not fully tested in the courts.

In Earlier Issues

A general nonprice equilibrium rather than a general price equilibrium may actually house the strongest forces involved in real problems. General price equilibrium may be more misleading than helpful in understanding the nature of economic problems.

Review of: *A Reconstruction of Economics*
(Kenneth E. Boulding)

John A. Baker

April 1951, Vol. 3, No. 2, p. 60

*The reviewer is an agricultural economist in the Natural Resource Economics Division, ESCS, stationed in Utah.

POLICY STUDIES JOURNAL,
VOLUME 6, NO. 4,
SUMMER 1978

*Reviewed by Preston E. LaFerney**

This somewhat unusual review features a journal issue in its entirety. The decision to review the entire issue stems from the subject matter—the Symposium on Agricultural Policy sponsored jointly by the Policy Studies Organization, the U.S. Department of Agriculture, and the Farm Foundation.

The *Policy Studies Journal*, published quarterly in the Political Science Department of the University of Illinois, represents the product of the Policy Studies Organization, a group composed largely of political scientists. Past issues have covered general approaches to policy studies and specific policy problem areas. (Contents of past symposia issues, available from the Policy Studies Organization, are listed on p. 588 of the summer 1978 issue.)

Contents of this issue include a brief, historical sketch of the Political Studies Organization; the symposium on agricultural policy, edited by Don Hadwiger of Iowa State University, William Browne of Central Michigan University, and Richard Fraenkel of the U.S. Agency for International Development; and three articles on public opinion as a factor in policy formulation, potential conflict between policy evaluators and persons responsible for policy formulation and administration, and questions useful in analyzing public policy. Lastly, a literature review section (a standard feature) provides a bibliography of policies on poverty and civil liberties, and brief essays on regulatory reform, criminal justice, health policy, and urban services.

*The reviewer is Deputy Director of the Commodity Economics Division, ESCS.

The Journal's editors quote Don Paarlberg, formerly USDA Director of Agricultural Economics: "The agricultural establishment has, in large measure, lost control." They cite this statement as indicative of a state of flux, in the late seventies, within involved political institutions and among items seriously considered on the agricultural policy agenda. Too, the statement prompted the Policy Studies Organization to focus this issue of the *Journal* on the questions of "what changes?" and "how much?"

Within the symposium section, the first seven articles present aspects of political institutions. More precisely, the authors focus on political institutions active in agricultural policy formulation now and in the past. They also examine evidences of significant changes within these institutions, and, in some cases, they indicate potential impacts on the policy process within the agricultural community.

The political institutions active in the agricultural policy process historically have comprised a tightly knit, closed group. The authors offer considerable evidence that this characteristic is changing, with the emergence of significant new participants in the development of agricultural policy. Charles Hardin, University of California-Davis, focuses on the political role of bureaucracy in setting agricultural policy, citing the Agricultural Adjustment Administration, the Production and Marketing Administration, the Commodity Stabilization Service, and USDA's Agricultural Stabilization and Conservation Service as institutions through which farm policy was heavily influenced by politicians with agricultural constituencies. He argues that no effective oversight was given by

either the executive branch or the Congress as a whole. Hardin points to the shift away from this situation in the sixties as the farm bloc's power eroded, culminating in various coalitions involving it and other interest groups—labor and consumer interests, particularly—in the formation of the 1973 farm bill.

Laurellen Porter, Indiana State University traces some recent, significant congressional changes which have eroded the power base of traditional agricultural interests, and examines the consequence for agricultural policy. Alex McCalla, University of California-Davis, examines the policies of the agricultural research establishment, arguing that inertia, not political manipulation, essentially governs research content in the short run. Only over time can specific interests (particularly those with money) significantly influence the research content.

Client support for agricultural agencies in the Congress is treated by Kenneth Meier, University of Oklahoma, who indicates recent erosion of such support for agricultural policy. Jonathan Lurie, Rutgers University, writes critically of regulatory (especially self-regulatory) features of the commodity exchanges. William Browne, Central Michigan University, and Charles Wiggins, Iowa State University, argue that the lobbying efforts of general farm organizations have changed from the historical ideological base toward the more pragmatic issues faced by their memberships—basic economic issues of farm legislation—and toward considerable involvement with other interest groups in their lobbying activities.

The rapidly emerging consumer organizations and their role in agricultural policy formulation are examined by James Guth, Furman University, as to their strengths and

UNSKILLED LABOR FOR DEVELOPMENT— ITS ECONOMIC COST

strategies in influencing agricultural policy.

Issues beyond the traditional area of agricultural policy form the topics of the next six articles. Authors look at who sets the agricultural policy agenda and examine "new" items, such as human rights, energy, and organic farming. Don Paarlberg argues that the real question in policy formulation is whether the high-priority issues on the agenda are relevant, not simply the choice among alternatives. Further, he points out that power to decide what is NOT on the agenda is critical to essential policy content. This power of the "establishment," he states, favored big farm operators for many years—until the sixties and continuing into the present, when a new set of challengers began to emerge from among the poor, the rural nonfarm people, hired farmworkers, minority groups, consumers, and environmentalists.

William Payne, previously with the U.S. Civil Rights Commission, argues that USDA largely continues to ignore the rural poor. Similarly, Isidro Ortiz, University of California-Santa Barbara, concludes that California, even under sympathetic administration, fails to provide farmworkers with collective bargaining although it is now a "right" under Federal law for most other workers.

Considering land and water policy relating to agriculture, Richard Esseks, Northern Illinois University, and John Richard, University of Wyoming, conclude that fragmentation and complexity of policies and a shifting power base increasingly favor municipalities and industries over agriculture in the use of these scarce natural resources. Garth Youngberg, Southeast Missouri

State University, addresses some potential concerns in his article on organic farming as an "alternative agriculture," as yet an essentially nonpolitical, embryonic movement.

The last three articles focus on the relationship between U.S. foreign policy and agricultural exports. "Sales Surpluses and the Soviets," "Grain as a Foreign Policy Tool . . .," and "The Failure of Food Power," by Trudy Peterson, Roy Laird, and Robert Paarlberg, respectively, indicate the policy issues examined. The authors look at implications of embargoes, use of agricultural commodities as instruments of foreign policy, and effects of foreign policy considerations on U.S. agricultural exports. Generally, they conclude that it is unrealistic to expect that U.S. policymakers will be able to restrict access to U.S. supplies of agricultural products, although just *how* they are made available to other nations can be affected by policy forces.

Each symposium article is a brief concise treatment of the given issue. Thus, the symposium constitutes an overview, reflecting the authors' perceptions of significant changes occurring in agricultural policy formulation and providing some attention to possible outcomes and impacts. The planners of the symposium succeeded, in my view, in arranging an informative treatment of the kinds and significance of changes occurring in the agricultural policy agenda and policy-forming processes in recent years—and in relating these changes to the political process.

The introductory symposium article, pages 463-466, provides a very good, more detailed summary of the topics and major conclusions of the various authors.

Orville John McDiarmid, The Johns Hopkins University Press, Baltimore, Md., 206 pages, 1977. Cloth, \$12.50; Paper, \$4.50.

*Reviewed by Jeanne M. O'Leary**

When selecting a project aimed at promoting economic development, planners often base their choice on cost-benefit or internal rate of return analyses. Developers consider the ratio of capital to labor to be utilized, and weigh the cost of these inputs against the yield to be gained from undertaking such a project. Computing return from the project, however, often excludes resulting social costs and benefits.

Orville John McDiarmid, author of *Unskilled Labor for Development—Its Economic Cost*, asserts that, in many developing countries in which the labor market functions inefficiently, particularly when high rates of unemployment and underemployment exist, the prevailing market wage rate inaccurately measures the cost of labor. When only the market wage is considered, it distorts not only selection of the project but also the choice of a production process so that factors are not employed to their maximum efficiency among alternative uses.

For developing countries with abundant, unskilled, underemployed labor, McDiarmid advocates the formulation and use of an economic or shadow price which would incorporate valuation of externalities incurred by society as a result of one's employment. Components of this economic price are the opportunity cost of labor, effect of employment on consumption, savings

*The reviewer is an economist in the Economic Development Division, ESCS.

and investment, and the redistribution of income.

McDiarmid presents a well-conceived rationale for rejecting the use of the market price of labor. First, he discusses the segmentation of the labor force in developing countries and subsequent wage discrepancies. He classifies the urban labor market into formal and informal sectors where the latter is composed of new arrivals from rural areas who are unable to find employment. As with unskilled rural workers, those in the informal urban sector are assumed to present an infinitely elastic supply with low marginal productivities. The formal urban sector is associated with workers earning higher wages from working at higher skill levels in more capital intensive production processes.

Wage differentials are exacerbated by increasing numbers of capital-intensive development projects which attract unskilled rural labor to urban areas that lack sufficient jobs to absorb these workers. Therefore, because the market price of labor in the formal sector is not adjusted for unemployment and underemployment, pressure on urban unemployment is aggravated from increased urban migration, further increasing societal costs.

McDiarmid then illustrates the effects of foreign investment on employment, unemployment, and the resulting market price of labor. Foreign aid, he points out, is confined largely to importing capital equipment, which distorts investment toward capital-intensive, rather than labor-utilizing, industries. Foreign-owned firms often pay higher wages, further encouraging substitution of capital for labor. In fact, the larger and less labor intensive agricultural

endeavors, McDiarmid states, tend to be the most highly subsidized because of lower risk and taxation. Therefore, he admonishes countries to be cognizant of what he calls the "suitability" gap, wherein technologies are adopted which may be ill-suited to the overall interests of the society's economic growth. McDiarmid advocates setting an economic price of labor at lower than market price when unemployment and underemployment exist.

In computing an economic price of labor, McDiarmid evaluates in detail the components of the Little-Mirrlees and the United Nations Industrial Development (UNIDO) methodologies. He prefers the UNIDO method because it accounts for the effect of income distribution on employing workers in jobs in which their wages are higher than in other alternatives. McDiarmid adds his own refinements to the two methods, one of which is the accounting of transfer costs associated with moving a person into a new job. His inclusion reflects the growing concern of labor economists over the duration of unemployment, costs incurred with search activity, and costs of training a worker for a new job.

Following his analyses, McDiarmid evaluates labor market conditions in four developing countries, attempting ultimately to compute a ratio of the economic price to the money wage. In perhaps the most disappointing section of the book, he attempts to calculate an economic price using secondary, national data, neglecting his caveats concerning need for regional estimates. Peppered throughout the text are what McDiarmid himself terms "heroic assumptions" of data, particularly on unemployment rates, which

could mildly be termed suspect.

Nevertheless, McDiarmid makes comparisons between Korea and Taiwan, two rapidly expanding, relatively full employment economies. Mindful of definitional differences in statistics and unreliability of estimates, he uses the existing data to present a very thorough discussion of effects of seasonality of agriculture, government intervention, and institutional constraints on the potential calculation of an economic price. Similarly, for Indonesia and the Philippines, two countries with problem underemployment and unemployment, the author presents a good analysis of the social costs of such factors as urban unemployment, resulting from rural-to-urban migration. McDiarmid was able to calculate, using these "heroic assumptions," ratios of economic price to money wage of 71 percent for Taiwan and 50 percent for the Philippines.

Development of the justification to utilize an economic rather than market price of labor, to incorporate social welfare costs and benefits in selection criteria for economic development projects, was thorough and judicious. However, his testing of this rigorous theoretical structure met with a typical frustration many researchers encounter: unreliable data. Use of primary sample data on a small-area basis might have reduced problems with unreliable data and provided a better test of the guidelines for developing an economic wage. However, the author's attention to the underutilization of unskilled labor for development, and the importance of incorporating the cost of externalities of employment in the economic price of labor, represent two important contributions of this book.

RURAL EMPLOYMENT DATA GAPS

By Clark Edwards*

Rural residents of the United States tend to have less access to economic opportunity than urban residents. Consequently, their incomes are lower and poverty is more intense. Federal programs have been initiated to promote rural economic development and seek balanced regional growth. Monitoring the effectiveness of these programs and researching proposed solutions to rural development problems presupposes an adequate data base. Yet major gaps exist in the data base currently available.

USDA economists have developed a handbook describing sources of rural employment data.¹ These sources include censuses, samples, and administrative records. The handbook also contains an assessment of data gaps. Data assessed were for rural employment, but the method used applies equally well to other rural data series, including population, income, health, and education. Several causes of data gaps examined in the handbook are summarized below.

OBSOLESCENCE

People have asked whether agricultural data in the U.S. systems are

obsolete.² This question implies that a data base once served the needs well, but that it has not changed over time as needs have. This is not the case with rural employment data. Rather, the nonfarm rural viewpoint was not considered when employment series were constructed. Some series measure farm employment and treat nonfarm employment as a residual, but over 90 percent of rural employment is nonfarm. Other series are national- and urban-oriented and treat nonmetropolitan data as the residual. Data for monitoring the economic well-being of the nonfarm, nonmetropolitan population have not been available, but now they are wanted.

INFORMATION NOT COLLECTED

There are some concepts for which no useful measures exist, simply because the data required are not collected. These include information on (1) local market structure, such as the degree of monopoly or competition in the rural labor market; (2) institutional arrangements, such as local laws, regulations, rule, and agreements which affect unions, zoning, or program benefits; and (3) values and attitudes related to the work ethic, quality of life, and non-monetary rewards. More information also needs to be gathered to measure underemployment, hidden unemployment, quality of jobs and workers, and productivity.

Collection of ungathered data would close some data gaps, but would leave untouched other, perhaps more important, problems. The other problems arise because many data already collected are not as useful as they might be if small changes were to be made in the series, and many data that are collected are available for urban research and policy uses but not for nonfarm rural uses.

REPORTING UNITS

Data collected from households have limited value in analyzing establishments; and, if these data are reported as aggregates by county or State they have limited value even for analyzing households. Some data tell us where people live; others, where they work. Some tell us about social and economic characteristics of workers; others, about the prices and quantities of resources and outputs associated with the work done. The unit used in initial data collection may be a household; the unit used in reporting the data may be a county; and the unit desired for program monitoring and analysis may be a labor market area.

Differences in the units suitable for observation, reporting, and analysis cause data gaps. To close all of these would require a data base so vast as to be prohibitively expensive. Thus, these are gaps we must live with. But they can be lessened if more attention is given to standardizing the household and establishment units of observation and to reconciling reporting units with analytic units. In addition, public use samples might be developed which establish linkages between, say, an establishment and the households of workers in that establishment.

*The author is senior economist in the Economic Development Division, ESCS.

¹ Clark Edwards, *et al.* "Employment Data for Rural Development Research and Policy," Econ., Stat., and Coop. Serv., U.S. Dept. Agr., EDD working paper no. 7809, 1978. Also available in: *Proceedings of Workshop on Agricultural and Rural Data*, Series B, Econ. Res. Serv., U.S. Dept. Agr., May 4-7, 1977.

² James T. Bonnen, *et al.* "Our Obsolete Data Systems: New Directions and Opportunities," *Am. J. Agr. Econ.*, Vol. 54, No. 5, Dec. 1972, pp. 867-875.

TIME

Most data collection methods involve inquiry into the status of the respondent as of a certain time. Occasionally, questions are asked about what the respondent was doing or where living, say, 5 years ago. These questions provide exceedingly useful information. But, for the most part, questions are not asked which allow for longitudinal studies of life cycles of establishments and households or for seasonal variations in employment patterns. Linkages, through social security numbers, of households in the 1970 public use sample to those in the 1960 sample illustrate the kind of time linkage which would increase the usefulness of the existing data base. Achieving such goals may not be easy. There are problems with privacy and confidentiality, accuracy of social security numbers, and additional costs. However, sampling techniques might be explored to circumvent these difficulties and to develop more longitudinal employment information from the existing data base.

PLACE

Rurality is in part a geographic concept. For rural development purposes, lack of geographic detail in published data is probably the most important source of data gaps. Rural data users want national data disaggregated into regional data. They want State data disaggregated into multicounty district data. And they want county data disaggregated into minor civil division data. Linkages among areal units are needed to trace flows of people, goods, and capital. Reports need to indicate where people live as well as where

they work, where goods are consumed as well as produced, and where capital is saved as well as invested.

Many of the geographically specific data needed for rural development policy and research are collected but not published. Some data cannot be supplied because of rules of disclosure, the volume of detail which can be included in publications, and the statistical unreliability associated with sparse observations in small areas. These difficulties can be overcome. But to do so requires that we overcome the urban bias which currently underlies reported data. Present sampling and reporting practices emphasize national information first, then State, and finally county. Large metropolitan areas survive this priority scheme because they are densely populated and the data allow detailed cross-tabulation without the limits of disclosure rules or sparse observations. Small rural areas do not survive this scheme and much of the useful information collected remains unused in the collecting agency's files.

This rural detail could easily be made available to rural-oriented users. For example, consider the four-digit industry detail collected for the Census of Manufacturing. For a single rural county, there are usually so few establishments in an industry that the central tendency there will not be statistically significant. Further, if there are so few that publication of the data might permit identification of an individual firm, the data are retained to prevent such disclosure. But available data would support a table published in virtually full detail for the nearly 2,000 rural counties in the United States. Many data would be publishable for the nonmetropolitan parts of census divisions and regions, or of States. Rural

development research and policy interests would be served if data now withheld for disclosure reasons were aggregated into rural combinations for which detailed employment and economic structures could be compared with currently published data for metropolitan areas.

The difficulty of excessive bulk if all collected data were published with maximum disclosable detail can be resolved with user-oriented data tapes, such as the public use sample tapes. Currently, special tapes are usually relatively expensive to obtain, edit, and learn to use. Reformatting these tapes for easier user access, and lowering the marginal cost to users, would increase the value of the existing data system.

UNRELIABILITY

Data are relatively more or less reliable dependent on the number of observations underlying a reported average, and also on the accuracy with which released data are edited. The statistical unreliability of sparse observations in small rural areas can be overcome either by aggregating rural areas into a larger geographic reporting unit as suggested above, or by increasing the sampling rates for rural areas in sample data. Recently, plans were made to expand the Current Population Survey (CPS) to include more rural as well as urban respondents. The sample was stratified to make employment estimates reliable at the State level. Perhaps when this sample is redesigned based on 1980 census information, it could also be stratified to provide statistical reliability for the nonmetropolitan parts of regions, divisions, or States.

Reliability problems associated with unedited data tapes which disagree with published data could be

resolved by regarding the tapes as one of the final forms in which official data are released, instead of as means to printing carefully edited reports.

Reliability problems associated with using statistical methods to impute rural area employment characteristics already in the file of reporting agencies could be improved by releasing more rural detail, as discussed earlier.

OPERATIONAL DEFINITIONS

Several data gaps occur because of the way the present data system is conceptualized. Alternative conceptualizations come slowly and they involve considerable interaction among policymakers, data suppliers, and researchers. For example, consider the limitation of the product-market orientation of the Standard Industrial Classification (SIC) codes. Employment, on the other hand, is a factor market concept, as are land and capital. There is often more variation in employment attributes within a SIC code than there is among codes. An alternative set of factor-market oriented codes is required which groups industries not by the similarity of outputs, but by the similarity of inputs. The development of an input-based industrial coding system is needed to monitor and analyze employment relative to capital, land, technology, water, energy, and the environment.

The initial conceptualization of a data series may appear differently to different persons. Until an operational measure becomes fixed in the statistical reporting process, there is opportunity for feedback and refinement in the conceptualization. For example, before a statistical measure

of unemployment was developed, a policymaker might have expressed a vague and qualitative concern for an unemployment problem. A statistician's effort to measure the concept of unemployment would add precision, but might also change the meaning from that which the policymaker intended. Another statistician might collect and publish data based on a slightly different operational definition. One theoretician might define the unemployment according to neoclassical competitive equilibrium theory, which would change the concept. Another theoretician might redefine the concept according to the Keynesian model, again changing the concept. Interchange among the policymakers, program evaluators, statisticians, and theoreticians might eventually lead to a mutually agreeable concept.

On the other hand, they might not agree, in which case a version not mutually agreeable likely would be provided; later, opportunities to claim data gaps would arise. This lack of agreement on conceptualization currently creates problems in developing operational measures of underemployment and hidden unemployment. Some of the difficulties rural development researchers and program monitors have with employment data arise because problems concerning the basic conceptualization of the theory and process of rural development are not yet solved.

INSTITUTIONS SUPPLYING DATA

The separation of data suppliers from data users through increased institutional size, economies of scale, and specialization has many advantages. However, this separation has also been identified as a source of

data gaps. Responsibility for determining data needs is frequently abdicated by the user, and the supplying agency is left to do the best it can with available time, ingenuity, and resources. Gaps in employment data for rural development could be reduced by increased communication and exchange among decision-makers who identify and respond to rural development problems, researchers who analyze and explain them, and data suppliers who collect information with which to describe them.

Users often do not know how to access the myriad of employment data now collected. More guides are needed, such as handbooks, data-oriented sections in professional journals, and user reports of data gaps encountered in program monitoring and research. The appendix referenced in footnote 1 is one example of a user guide. The now obsolete, out-of-print supplement to *Economic Indicators* is a better example.³ Such handbooks should be updated periodically with reliable and useful information.

* * *

In conclusion, many gaps exist in the data used for rural development research and policy. Some are formidable—their resolutions would not be cost effective and we must learn to live with them. Others can be ►

³ 1967 Supplement to *Economic Indicators: Historical and Descriptive Background*. Joint Economic Committee, U.S. Congress, U.S. Govt. Print. Off., Washington, D.C., 1967.

Suggestions for Submitting Manuscripts for *Agricultural Economics Research*

Contributors can expedite reviewing and printing of their papers by doing these things:

1. **SOURCE.** Indicate in a memorandum how the material submitted is related to the economic research program of the U.S. Department of Agriculture and its cooperating agencies. State your own connection with the program.
2. **CLEARANCE.** Obtain any approval required in your own agency or institution before sending your manuscript to one of the editors of *Agricultural Economics Research*. Attach a copy of such approval to the manuscript.
3. **ORIGINALITY OF MATERIAL.** It is our policy to print original material. We consider alternative treatments of material published elsewhere, but such treatments need to differ substantially from the original approach. When submitting your manuscript, identify, if applicable, related material either published or submitted for publication.
4. **ABSTRACT.** Include an abstract and at least three keywords when you submit your article. The abstract should not exceed 100 words.
5. **NUMBER OF COPIES.** Submit three good copies.
6. **TYPING.** Double space everything, including abstract and footnotes.
7. **FOOTNOTES.** Number consecutively throughout the paper.
8. **REFERENCES.** Check all references carefully for accuracy and completeness.
9. **CHARTS AND OTHER ARTWORK.** Use charts sparingly for best effect. Keep design as simple as possible to improve communication. Submit all artwork in draft rather than final form, accompanied by neatly prepared pages with essential data for replotting.

Microfiche copies are available from two different sources: Microfilming Corporation of America, 21 Harristown Road, Glen Rock, NJ 07452, 1974 on: \$4.95 per year or per issue; Congressional Information Service, Inc., P.O. Box 30056, Washington, D.C. 20014, 1973: \$5(2 fiche), 1974 on: average is 3 fiche per year (\$3.75 first fiche, \$1.25 each remaining fiche).

(Continued from page 46)

narrowed at nominal (virtually zero) cost, simply if small changes are made in data collection and reporting methods. Some of the most troubling gaps for data users appear to stem from reporting agency bias. Agricultural agencies, focusing on farm data, fail to collect and report related rural nonfarm information. Other agencies are urban oriented; application of agency rules and habits as to disclosure, volume, and reliability result in

a relative abundance of urban detail. But the rural-oriented detail collected is never made readily accessible to rural-oriented users.

The rural point of view is often not presented in meetings in which changes in census, sample, and administrative data are discussed. Sometimes a data gap can be closed by slight changes in the way a question is worded on a questionnaire, a sample is stratified, or sorting and

merging is done that underlies the publication of a table. Relatively large gains can be had at nominal cost if the rural point of view is expressed at the appropriate moment in the planning process. Rural employment data users should become more involved with the development of rural-based data series. To achieve this end, nonfarm rural interests should have greater representation on Federal data committees.

UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D.C. 20250

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE, \$300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF
AGRICULTURE
AGR 101

THIRD CLASS

